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Alberta Society of Petroleum Geologists, Journal. Calgary, Alberta.
American Geological Institute, Report. Washington, D. C.
American Geophysical Union, Geophysical Monograph. Washington, D. C.
American Journal of Science. New Haven, Connecticut.
American Museum of Natural History, American Museum Novitates. New York.
American Society of Civil Engineers, Soil Mechanics and Foundations Division, Journal. New York.
Arctic (Arctic Institute of North America). Montreal.
Association of American Geographers, Annals. Lawrence, Kansas.
British Columbia, Minister of Mines, Annual Report. Victoria, British Columbia.
California Institute of Technology, Division of Geological Sciences, Contribution. Pasadena, California.
California, University (Los Angeles), Institute of Geophysics, Publication.
Canada, Geological Survey, Economic Geology Series; Map; Memoir; Paper. Ottawa.
Columbia University, Lamont Geological Observatory, Contribution. Palisades, New York.
Earlham College, Science Bulletin. Richmond, Indiana.
Earth Science. Chicago.
Florida State Museum, Bulletin, Biological Sciences. Gainesville, Florida.
Geochimica et Cosmochimica Acta. London-New York.
Geological Society of America, Bulletin. New York.
Indiana, Geological Survey, Mineral Economics Series; Report of Progress. Bloomington, Indiana.
International Geology Review (American Geological Institute). Washington, D. C.
Mineral Industries (Pennsylvania State University, College of Mineral Industries). University Park, Pennsylvania.
Montana Bureau of Mines and Geology, Bulletin. Butte, Montana.
National Academy of Sciences-National Research Council, Publication. Washington, D. C.
National Speleological Society, Bulletin. Alexandria, Virginia.
New Mexico, Bureau of Mines and Mineral Resources, Bulletin; Geologic Map. Socorro, New Mexico.
Oklahoma Geological Survey, Bulletin. Norman, Oklahoma.
Oklahoma Geology Notes (Oklahoma Geological Survey). Norman, Oklahoma.
Ontario Dept. of Mines, Annual Report. Toronto.
Pennsylvania Academy of Science, Proceedings. [Pittsburgh, Pennsylvania].
Pennsylvania, Bureau of Industrial Development, Plant Location Factors Report. Harrisburg, Pennsylvania.
Pennsylvania Geological Survey, Bulletin, Information Circular. Harrisburg, Pennsylvania.
Pennsylvania State University, Mineral Industries Experiment Station, Circular. University Park, Pennsylvania.
Photogrammetric Engineering (American Society of Photogrammetry). Washington, D. C.
Purdue University, Engineering Extension Dept., Engineering Bulletin, Extension Series. Lafayette, Indiana.
Quebec (Province), Dept. of Mines, Preliminary Report. Quebec.
San Diego Society of Natural History, Transactions. San Diego, California.
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Smithsonian Institution, Smithsonian Miscellaneous Collections. Washington, D. C.
Tulsa Geological Society, Digest. Tulsa, Oklahoma.
U. S. Geological Survey, Bulletin; Circular; Geophysical Investigations Map; Mineral Investigations Map; Miscellaneous Investigations Map; Oil and Gas Investigations Map; Professional Paper; Reports, Open-File Series; Trace Elements Investigations Report; Water-Supply Paper. Washington, D. C.
U. S. Snow, Ice and Permafrost Research Establishment, Research Report; Technical Report. Wilmette, Illinois.
Virginia Polytechnic Institute, Bulletin; Engineering Experiment Station Series. Blacksburg, Virginia.
Washington, Division of Mines and Geology, Information Circular. Olympia, Washington.
West Virginia Geological and Economic Survey, Report of Investigations. Morgantown, West Virginia.

INDEX TO VOLUME I

The subject and author indexes to Volume I of GeoScience Abstracts are now being assembled. They will be published as a separate and sent to all subscribers to Volume I in March 1960.

GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

e also: Geomorphology 2-60; Fuels 2-246.

1. Tipper, H.W. GEOLOGY, QUESNEL, CAR-OO DISTRICT, BRITISH COLUMBIA: Canada, eol. Survey, Map 12-1959, scale 1:253, 440, mar-nal notes, 1959.

Preliminary series geological map of some 6, 000 . mi. in central British Columbia. Much of the area covered with a thick mantle of glacial drift. In the stern part are large areas of sediments of the ache Creek group, mainly of Permian age. In the E. and NW. corners are exposures of mainly vol-nic rocks of a Middle Jurassic Hazelton group. In northerly-trending belt through the W. center of e area are clastic sediments of Jurassic or Creta-ous age. Also in the eastern part of the area are posures of granitic rocks of Mesozoic age.

Exposures of the above rocks are separated from ch other by glacial drift or Tertiary rocks, which e widespread throughout. The oldest of the Tertiary cks are mainly acid volcanic rocks of Paleocene d/or Eocene age. Of Eocene and/or Oligocene age e clastic sediments and volcanic rocks that rest conformably on the older formations. Overlying l these is a succession of plateau-type, undeformed, at-lying basalt and andesite with minor clastic sed-nents. These are of Miocene or possibly Pliocene e. One extinct, but post-glacial, volcanic cone curs in the NW. corner of the area, debris from nich overlies glacial till.

Mineral occurrences are known in many of the der rocks in the area but none is as yet of economic portance. Several occurrences of diatomite are own, one of which is probably much more than 25 thick. --H. M. A. Rice.

2. Kretz, Ralph. GEOLOGY, NORTHERN DIAN LAKE, MANITOBA: Canada, Geol. Survey, ap 2-1959, scale 1:253, 440, marginal notes, 1959.

Preliminary series geological map covering some 300 sq. mi. in northern Manitoba, 100 mi. or so V. of Churchill. Some 90% of the area is covered th drift, but locally outcrops are good. All rocks e of Precambrian age. The oldest consist of schist, eiss, and amphibolite, and are surrounded by dies of plutonic rocks ranging from granodiorite the syenite.

The rocks are broadly folded about steeply plung-g axes. The general foliation shows considerable versity, but it has a general easterly trend. --H. M. Rice.

3. Lee, Hulbert A. SURFICIAL GEOLOGY, ROOSTOOK, VICTORIA COUNTY, NEW BRUNS-CK: Canada, Geol. Survey, Map 34-1959, scale 63,360, marginal notes, 1959, ref.

eliminary series map covering about 240 sq. mi. e area lies adjacent and S. of Grand Falls map-ea. The principal surficial deposits are valley ain gravels from the Grand Falls moraine deposited the main Wisconsin ice sheet. Many present topo-aphic features were produced by an ancestral St. n River eroding into these gravels and underlying l deposits. Till is locally up to 55 ft. in thickness, d the map includes fabric diagrams for 3 layers of l in 1 key section where a subtill sand is exposed. lumnar sections show the stratigraphic succession 15 localities indicated on the map. --P. Harker.

2-4. Lee, Hulbert A. SURFICIAL GEOLOGY, GRAND FALLS, MADAWASKA AND VICTORIA COUNTIES, NEW BRUNSWICK: Canada, Geol. Survey, Map 24-1959, scale 1:63, 360, marginal notes, 1959, 2 refs.

Preliminary series map covering about 400 sq. mi. A major lobe of the Wisconsin ice sheet occupied the St. John River Valley, and the Grand Falls moraine was formed during recession and minor readvance of the ice. The moraine blocked the valley, forming glacial Lake Madawaska and provided material for abundant outwash and valley train deposits of the Grand Falls drift. Radiocarbon dating of peat, over-lain by sediments younger than the Grand Falls drift shows the minimum age of the Grand Falls drift to be approximately 10, 200 years. Rill patterns in the southern part of the area trend at right angles to the Grand Falls moraine and reflect meltwater erosion from the ice margin lying to the NW. Columnar sec-tions show the stratigraphic succession for 13 local-ities indicated on the map. --P. Harker.

2-5. Blackadar, Robert G. GEOLOGY, CAPE DORSET, BAFFIN ISLAND, DISTRICT OF FRANK-LIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 11-1959, scale 1:126,720, marginal notes, 1959.

Preliminary series map of some 40 mi. along the S. coast of Cape Dorset, SW. Baffin Island. Rocks underlying the area are all of Precambrian age and may be broadly divided into metasedimentary and granitic rocks, although in many places no clear contact can be drawn between the 2. The plutonic rocks include granitic gneiss, migmatite, and possi-bly some intrusive granitic rocks. Interbanded with these in 1 place is much amphibolite and biotite gneiss. The metasediments included quartzite, marble, schist, and gneiss.

Major fold axes trending NW. dominate the struc-tural pattern of the area. Although no faults are shown on the map, there is abundant evidence the area has been faulted as well as folded.

Raised beaches were observed as high as 550 ft. above present sea level although most are between 200 and 250 ft. above sea level. Marine shells were collected from deposits as high as 240 ft. --H. M. A. Rice.

2-6. Davison, W. L. GEOLOGY, FOXE PENIN-SULA (EASTERN PART), BAFFIN ISLAND, DIS-TRICT OF FRANKLIN, NORTHWEST TERRITORIES: Canada, Geol. Survey, Map 4-1959, scale 1:253, 440, marginal notes, 1959.

Preliminary series reconnaissance geological map of a 70-mi. stretch along the SW. coast of Baffin Is-land. The area is underlain by a succession of gneisses, schists, crystalline limestone, and quartz-ite, of Archean and/or Proterozoic age. Intercalated with these rocks, in places conformably and in places with cross cutting relationships, are layers, zones, and irregular masses of amphibolite, pyroxene rock, peridotite, and pyroxenite. Bodies of gneiss and granitoid gneiss are common throughout the area but their relations with the other rocks is uncertain. All the above rocks are cut by diabase dikes of Protero-zoic age.

Structures are complex and highly variable. The predominant plunge of tight folds is WNW. with many reversals, and these folds are commonly overturned

from the N. Other less strongly folded structures trend N. to NE. Dome- and basin-structures, circular or elliptical in plan, reflect transverse warping of isoclinally folded strata.

Concentrations of magnetite occur, largely confined to narrow belts in which metasediments and mafic rocks are associated. The magnetite is nearly everywhere coarse grained. Some of the showings were being explored during the summer of 1958. --H. M. A. Rice.

2-7. Stevenson, I. M. **GEOLOGY, CHEDABUCTO BAY, GUYSBOROUGH AND RICHMOND COUNTIES, NOVA SCOTIA: Canada, Geol. Survey, Map 3-1959, scale 1:63, 360, marginal notes, 1959.**

Preliminary series geological map of the extreme eastern part of the mainland of Nova Scotia. The oldest rocks known are volcanic and sedimentary rocks of the Fourchu group of Proterozoic age. These are overlain by slates, quartzites, and schists of the Ordovician? Meguma group which are cut by granites and related rocks of probable Devonian age. In fault contact with the Meguma rocks is a succession of Mississippian sediments belonging to the Horton, Windsor, and Canso groups. The Paleozoic sedimentary succession is completed with a few scattered outcrops of conglomerate of probable Pennsylvanian age. Intrusive into what are believed to be Horton rocks are 2 small plutons of fine-grained granitic rock. Near the head of Chedabucto Bay are the only representatives of the Mesozoic, outcrops of red conglomerate, sandstone, and shale of Triassic age.

The region has been subjected to at least 2 major periods of folding. During the first, strata of the Meguma group were flexed into a series of tight, E.-trending folds. The postorogenic Devonian? granites were relatively undisturbed. During the second, a post-Mississippian and pre-Triassic period of folding, sediments of Mississippian age were flexed into a series of folds with a generally N. trend. The Devonian granites apparently acted as resistant buttresses during this second period of folding. Triassic rocks were only gently folded.

Some exploration has recently been carried out on a W deposit consisting mainly of scheelite that formed as a coating on fracture surfaces and as tiny veinlets in quartzite. A small deposit of massive specular hematite veins cutting Horton quartzites were mined many years ago. There has also been some prospecting for Au and Cu at several localities. --H. M. A. Rice.

2-8. Frarey, M. J. **GEOLOGY, ECHO LAKE, DISTRICT OF ALGOMA, ONTARIO: Canada, Geol. Survey, Map 23-1959, scale 1:63, 360, marginal notes, 1959, 2 refs.**

The center of the area lies about 30 mi. E. of Sault St. Marie, Ontario, in the District of Algoma. Part of the map-area was included in the "original Huronian area" of Logan and Murray.

All rocks are of Precambrian age. A pre-Huronian basement complex underlies the northern two-thirds or more of the area and consists of granitic gneisses and innumerable large and small remnants of partly absorbed, granitized amphibolite. A thick sequence of Huronian strata lies on this basement with marked unconformity; these include quartzite, polymictic conglomerate, conglomeratic graywacke, and lesser amounts of argillite, limestone, and arkose. Areas of rocks previously classed as Mississagi formation are reassigned to the Serpent, Gowganda, and Lorrain formations. In addition, previously unmapped Huronian volcanic rocks are described. Numerous dikes and sills of gabbro and related rocks intrude both basement and Huronian strata. No post-Huronian granite is recognized.

The Huronian strata dip homoclinally southward and southwestward at moderate angles. Little or no unconformity separates the Bruce and Cobalt groups. The rocks are fractured and faulted along 2 well-marked directions trending NW. and NE. Some of the strike faults disturbed the normal stratigraphic sequence.

Although numerous showings of chalcopyrite and a few radioactive occurrences are known in the area, none has so far proved of economic importance. --Auth.

2-9. Donaldson, J. A. **GEOLOGY, MARION LAKE, QUEBEC - NEWFOUNDLAND: Canada, Geol. Survey, Map 17-1959, scale 1:63, 360, marginal notes, 1959.**

Preliminary series geological map of some 250 sq. mi. in the E. side of the 'Labrador Trough' about 30 mi. E. of Schefferville. The E. margin of the 'trough' rocks is a northerly-trending fault in the E. third of the area, E. of which are gneisses and schists of Archean or Proterozoic age. Intercalated with these are bodies of amphibolite and gabbro. The 'trough' rocks themselves are intricately interbanded slates, phyllites, dolomites, quartzites, basalts, tuffs, and breccias, of the Knob Lake, Murdock, and Doublet groups. These are intruded by thick sills of gabbro and other basic rocks. All are of Proterozoic age.

The structure is complex and dominated by northwesterly-trending folds and faults. Disseminated pyrite, chalcopyrite, and pyrrhotite occur along shear zones in the volcanic rocks and at the contacts of basic sills. The Labrador Mining and Exploration Company drilled some of the sulfite bodies during the past summers. --H. M. A. Rice.

2-10. McLean, Brian. **SASKATCHEWAN AND WESTERN MANITOBA, SHOWING OIL AND GAS FIELDS: 5th ed., Canada, Geol. Survey, Map 1044A, scale 1:267, 200, 1959.**

This map, which is annually revised, does not show geology but gives the shapes and positions from all known oil and gas fields, new discoveries of oil and gas, pipelines constructed, and position of refineries. The stratigraphic position of producing wells is also shown. --H. M. A. Rice.

2-11. Radbruch, D. H. **FORMER SHORELINE FEATURES ALONG THE EAST SIDE OF SAN FRANCISCO BAY, CALIFORNIA: U. S. Geol. Survey, Misc. Inv. Map I-298, scale 1:48, 000, contour intervals 5 and 25 ft., 1959.**

A map and a brief text show the boundaries of former shores, ponds, and tidal flats, and streams now filled or concealed, as well as the area of former tidal flats, along part of the E. side of San Francisco Bay. These data are plotted on topographic maps. Foundation conditions are discussed for the area between the present and former shorelines, which is now largely covered by artificial fill overlying bay mud. --U. S. Geol. Survey.

2-12. Ekren, E. B., and F. N. Houser. **PRELIMINARY GEOLOGIC MAP OF THE MOQUI SE**

UADRANGLE, MONTEZUMA COUNTY, COLO-ADO: U.S. Geol. Survey, Mineral Inv. Map MF-21, scale 1:24,000, lat. 37°15'-37°22'30"N., ong. 108°45'-108°52'30"W., 1959.

-13. Gardner, Louis S. GEOLOGIC MAP OF HE LEWISTOWN AREA, FERGUS COUNTY, ONTANA: U.S. Geol. Survey, Oil & Gas Inv. Map M-199, scale 1:63,360, 1959.

The area, covering 410 sq. mi., extends from the othills of the Big Snowy Mountains on the S. to the dith and Moccasin mountains on the N. Outcropping cks range in age from Mississippian to Recent. brief text discusses stratigraphic formations, ructural features, and mineral resources. Com-ercial deposits of gypsum, coal, gravel, brick-aking material, and also several potential oil ructures are present. Fourteen oil and gas wells ave been drilled in the area, without commercial roduction.--U. S. Geol. Survey.

-14. Smith, Clay T., and A.J. Budding. ECONNAISSANCE GEOLOGIC MAP OF LITTLE LACK PEAK FIFTEEN-MINUTE QUADRANGLE, AST HALF: New Mexico, Bur. Mines & Mineral esources, Geol. Map 11, scale 1:62,500, 1959.

The map, prepared by the authors as a result of apping for the New Mexico Institute of Mining and echnology summer geologic field course, shows eologic features of about 135 sq. mi. in western incoln County, New Mexico. Rock units differenti-ed are the Permian San Andres formation; Triassic ernal, Santa Rosa, and Chinle formations; Creta-eous Dakota and Mancos formations; Tertiary vol-anic and intrusive rocks; and Quaternary basalt ows and terrace gravels. Along the SE. edge of the ap a series of domal structures appear related to xposed and hidden laccolithic or stocklike intrusions monzonite, but in much of the area the beds dip less than 10° with no major structures other than e gentle syncline SSW. of Coyote.

The Bernal formation, classified as Permian in ge at its type locality, is listed with the Triassic its because of its unconformable relationships on e middle Permian San Andres limestone.--F. E. ottlowski.

15. Weber, Robert H., and Max E. Willard. ECONNAISSANCE GEOLOGIC MAP OF MOGOLLON HIRTY-MINUTE QUADRANGLE: New Mexico, ır. Mines & Mineral Resources, Geol. Map 10, ale 1:126,720, 1959.

16. Bromery, Randolph W., Gerald L. Zandle, d others. AEROMAGNETIC MAP OF THE VALLEY ORGE QUADRANGLE, CHESTER, MONTGOMERY, ND DELAWARE COUNTIES, PENNSYLVANIA: U.S. eol. Survey, Geophys. Inv. Map GP-200, scale 24,000, contour interval 50 gammas, lat. 40°-40° '30"N., long. 75°22'30"-75°30'W., 1959.

17. Bromery, Randolph W., Gerald L. Zandle, d others. AEROMAGNETIC MAP OF PART OF IE NORRISTOWN QUADRANGLE, PHILADELPHIA, HESTER, DELAWARE, AND MONTGOMERY COUN-ES, PENNSYLVANIA: U.S. Geol. Survey, eophys. Inv. Map GP-201, scale 1:24,000, contour terval 50 gammas, lat. 40°-40°07'30"N., long. °15'-75°22'30"W., 1959.

2-18. Bromery, Randolph W., Bruce L. Bennett, and others. AEROMAGNETIC MAP OF THE MAL-VERN QUADRANGLE, CHESTER COUNTY, PENN-SYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-202, scale 1:24,000, contour interval 50 gammas, lat. 40°-40°07'30"N., long. 75°30'-75°37'30"W., 1959.

2-19. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF PART OF THE WEST CHESTER QUADRANGLE, CHESTER AND DELAWARE COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-203, scale 1:24,000, contour interval 50 gammas, lat. 39° 52'30"-40°N., long. 75°30'-75°37'30"W., 1959.

2-20. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF PART OF THE MEDIA QUADRANGLE, CHESTER AND DELA-WARE COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-204, scale 1:24,000, contour interval 50 gammas, lat. 39°52'30"-40°N., long. 75°22'30"-75°30'W., 1959.

2-21. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE EAST GREENVILLE QUADRANGLE, BERKS, LEHIGH, AND MONTGOMERY COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-205, scale 1:24,000, contour interval 50 gammas, lat. 40°22'30"-40°30'N., long. 75°30'-75°37'30"W., 1959.

2-22. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE MIL-FORD SQUARE QUADRANGLE, BUCKS, LEHIGH, AND MONTGOMERY COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-206, scale 1;24,000, contour interval 50 gammas, lat. 40°22'30"-40°30'N., long. 75°22'30"-75°30'W., 1959.

2-23. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE SASSA-MANSVILLE QUADRANGLE, MONTGOMERY AND BERKS COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-207, scale 1:24,000, contour interval 50 gammas, lat. 40°15'-40°22'30"N., long. 75°30'-75°37'30"W., 1959.

2-24. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE PER-KIOMENVILLE QUADRANGLE, MONTGOMERY AND BUCKS COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-208, scale 1;24,000, contour interval 50 gammas, lat. 40°15'-40°22'30"N., long. 75°22'30"-75°30'W., 1959.

2-25. Bromery, Randolph W., Bruce L. Bennett, and others. AEROMAGNETIC MAP OF THE PHOE-NIXVILLE QUADRANGLE, CHESTER AND MONT-GOMERY COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-209, scale 1:24,000, contour interval 50 gammas, lat. 40°07'30"-40°15'N., long. 75°30'-75°37'30"W., 1959.

2-26. Bromery, Randolph W., Bruce L. Bennett, and others. AEROMAGNETIC MAP OF THE ALLEN-TOWN QUADRANGLE, NORTHAMPTON, LEHIGH, AND BUCKS COUNTIES, PENNSYLVANIA: U.S.

Geol. Survey, Geophys. Inv. Map GP-213, scale 1:24, 000, contour intervals 50 and 250 gammas, lat. 40°30'-40°45'N., long. 75°15'-75°30'W., 1959.

2-27. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE QUAKERTOWN QUADRANGLE, BUCKS COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-214, scale 1;24, 000, contour interval 50 gammas, lat. 40°22'30"-40°30'N., long. 75°15'-75°22'30"W., 1959.

2-28. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE BUCKINGHAM QUADRANGLE, BUCKS COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-215, scale 1:24, 000, contour interval 50 gammas, lat. 40°15'-40°22'30"N., long. 75°-75°07'30"W., 1959.

2-29. Bromery, Randolph W., John R. Henderson, Jr., Bruce L. Bennett, and others. AEROMAGNETIC MAP OF PARTS OF THE LAMBERTVILLE AND STOCKTON QUADRANGLES, BUCKS COUNTY, PENNSYLVANIA, AND HUNTERDON AND MERCER COUNTIES, NEW JERSEY: U.S. Geol. Survey, Geophys. Inv. Map GP-216, scale 1:24, 000, contour interval 50 gammas, lat. 40°15'-40°25'N., long. 74° 52'30"-75°W., 1959.

2-30. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE SAFE HARBOR QUADRANGLE, LANCASTER AND YORK COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-217, scale 1:24, 000, contour interval 50 gammas, lat. 39°52'30"-40°N., long. 76° 22'30"-76°30'W., 1959.

2-31. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE CONESTOGA QUADRANGLE, LANCASTER COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-218, scale 1:24, 000, contour interval 50 gammas, lat. 39°52'30"-40°N., long. 76°15'-76°22'30"W., 1959.

2-32. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE QUARRYVILLE QUADRANGLE, LANCASTER COUNTY, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-219, scale 1:24, 000, contour interval 50 gammas, lat. 39°52'30"-40°N., long. 76°07'30"-76° 15'W., 1959.

2-33. Bromery, Randolph W., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE MORGANTOWN QUADRANGLE, BERKS, LANCASTER, AND CHESTER COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-220, scale 1:24, 000, contour interval 50 gammas, lat. 40°07'30"-40°15'N., long. 75°52'30"-76°W., 1959.

2-34. Bromery, Randolph W., John R. Henderson, Jr., Gerald L. Zandle, and others. AEROMAGNETIC MAP OF THE ELVERSON QUADRANGLE, BERKS AND CHESTER COUNTIES, PENNSYLVANIA: U.S. Geol. Survey, Geophys. Inv. Map GP-221, scale 1:24, 000, contour intervals 50 and 250 gammas, lat. 40°07'30"-40°15'N., long. 75°45'-75°52'30"W., 1959.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Geomorphology 2-55; Geophysics 2-167; Geohydrology 2-194; Mineral Deposits 2-201; Fuels 2-245.

2-35. Jones, A.G. VERNON MAP-AREA, BRITISH COLUMBIA: Canada Geol. Survey, Mem. 296, 186 p., 27 illus., 2 maps (Map 1059 A in pocket, scale 1 in. to 4 mi.), 3 charts, 9 secs., 19 diags., table, 1959, 82 refs.

The map-area covers some 6,100 sq. mi., partly in the deeply dissected interior plateau of British Columbia and partly in the Monashee Mountains. Most of it is underlain by rocks of the Shuswap terrane and the description and discussion of the age and structure of this controversial series is one of the principle contributions of this study. Rocks of the Cache Creek group mainly of Permian age, Tertiary lavas, and late Mesozoic granitic intrusions underlie nearly all the remainder of the area.

The name Shuswap terrane was applied to a series of highly metamorphosed rocks near Shuswap Lake by Dawson in 1898 and was later extended by others to include a host of metamorphic rocks throughout southern British Columbia. Hypotheses applicable to these remote areas have been extended to include the type locality where they do not apply. In this report therefore the term Shuswap is a stratigraphic unit used much as Dawson intended it. The Shuswap terrane is divided into 3 groups whose stratigraphic relations to one another is uncertain. The 3 groups are similar in metamorphism and structure and, as a whole, are distinguished from neighboring formations by a marked and abrupt contrast in stratigraphy, lithology, metamorphism, and structure. The Monashee group consists mainly of gneiss but with some schist, calcareous gneiss, and marble. The rocks exhibit metamorphism of a uniformly high grade. The stratigraphic thickness is at least 60,000 ft. The Mount Ida group consists of both sedimentary and volcanic rocks, the former predominating, but unlike the Monashee group, has been divided into 6 lithologically distinct formations. It also is probably 60,000 ft. thick. The Chapperon group consists of a mixed assemblage of sedimentary and volcanic rocks that closely resemble part of the Mount Ida group.

Two main periods of deformation are recorded in the Shuswap rocks, differing in nature, geometry, and tectonic orientation. The effects of the younger are superimposed on those of the older. The younger is the deformation characteristic for the surrounding formations, which are Permian and younger in age. The older is restricted to the Shuswap and consists of a pervasive, isoclinal, recumbent folding and intense nearly horizontal shearing, apparently mainly parallel with the bedding. It is concluded that the Shuswap terrane is definitely pre-Permian and may well be Precambrian in age.--H. M. A. Rice.

2-36. Baird, David M. FOGO ISLAND MAP-AREA, NEWFOUNDLAND: Canada, Geol. Survey, Mem. 301, 43 p., 6 illus., Map 1065 A (in pocket, scale 1:63, 360), table, 1958, 17 refs.

Fogo Island, some 110 sq. mi. in area, lies off the NE. corner of Newfoundland. Included in this report are some of the adjacent islands and part of Port Albert peninsula of the mainland.

Rocks of the Fogo Island map-area comprise Ordovician and Silurian sedimentary and volcanic rocks, and younger intrusive rocks that vary widely in composition.

The core of Fogo Island is a batholith of pink to gray microcline granite, which is cut by many dikes of various composition. The southern edge of Fogo Island is underlain by a complex of dioritic and gabbroic intrusive rock, which is intruded by granitic dikes. Remnants of a thick series of metamorphosed sandstone and shale with some volcanic members extend along the W. and SW. coasts of Fogo Island and northward-dipping, altered sandstone and shale underlie a series of altered lavas and pyroclastic rocks on the peninsula on the NW. corner of this island.

Wadham islands, all save Copper Island, in the SE. corner of the map-area consist largely of coarse, pegmatitic granite. Copper Island is underlain by dioritic and gabbroic intrusive rocks and remnants of digested sediments, all of which are cut by granitic dikes.

Two distinct rock groups underlie Change islands. The S. end of South Change Island is an anticline of massive quartzite and some phyllite and slate, and another anticline of the same quartzite and slate crosses the N.-central part of this island. Between the 2 is a synclinal mass of coarse agglomerate, slaggy, red lava, and ash beds, and similar rocks underlie the northern tip of South Change Island and all of North Change Island.

The part of Port Albert peninsula included in Fogo Island map-area is underlain by quartzite and phyllite along the S. shore, and by lava and conglomerate on the N. side.

Indian islands, the southern Dog Bay islands, and adjacent islands consist of slate, phyllite, quartzite, conglomerate, and thin limestone lenses of Silurian age. They are part of a large syncline of Silurian strata that extends southward beyond the map-area. Two small islands that lie between the Indian islands and the Dog Bay islands consist of volcanic rock and conglomerate that resemble the rock found on the N. side of Port Albert peninsula. --H. M. A. Rice.

2-37. Langford, F. F. GEOLOGY OF THE GRIPP LAKE AREA: Ontario Dept. Mines, Ann. Rept. 1958, v. 67, pt. 3, 22 p., 6 illus., 3 maps (1 in pocket, scale 1:31,680), 1959, 3 refs.

The Gripp Lake area (approx. $50^{\circ}19'$-$50^{\circ}27'$N. $87^{\circ}30'$-$87^{\circ}41'$W.) in the Thunder Bay district of Ontario covers about 75 sq. mi. The discovery of a chalcopyrite showing S. of the lake in fall 1954 started a rush that continued during the following winter. The present survey, made in summer 1955, was the result of this activity.

The abundant outcrops S. of the lake form NE.-trending ridges. N. of the lake only a few outcrops show through heavy sand and gravel cover. The central part of the area is largely occupied by swamp, in which occur large scattered outcrops. All consolidated rocks are Precambrian. "The dominant rocks are those of the Marshall Lake group, which are composed mainly of quartzite. Interbanded with the quartzite are a few bands of phyllite and iron formation. In conformable contact with the Marshall Lake quartzites are amphibole schists and gneisses, which occupy the southern part of the area. Intruding the schists and gneisses along the S. border of the area are large masses of syenite and granite. All these rocks have been intruded by a group of diorite, lamprophyre, and hornblendite dikes, which are in turn cut by N.-striking diabase dikes. Over the consolidated rocks lie Pleistocene sand and gravel, recent alluvium, and swamp deposits."

The occurrences of sulfide minerals can be divided into 2 groups, one associated with brecciation and shear zones in the quartzite and the other with iron formation. Showings S. and W. of Marshall Lake belong primarily to the first group. The deposits are chiefly disseminated chalcopyrite and pyrite, compared with abundant pyrrhotite in deposits of the other type. The bands of iron formation N. of Willet Lake contain shoots of massive sulfides, primarily pyrrhotite and pyrite. Some of the deposits are described. --A. C. Sangree.

2-38. Beall, G. H. PRELIMINARY REPORT ON CROSS LAKE AREA, NEW QUEBEC: Quebec, Dept. Mines, Prelim. Rept. no. 396, 9 p., fold. geol. map (Prelim. Map no. 1267), scale 1:63,360, 1959, 2 refs.

The Cross Lake area (74°-$74^{\circ}20'$N. $61^{\circ}30'$-$61^{\circ}45'$ W.), mapped in 1958 comprises about 190 sq. mi. in the E. central part of the Cape Smith-Wakeham Bay belt. This belt trends E. and consists of Proterozoic folded and faulted volcanic, sedimentary, and intrusive rocks which unconformably overlie an Archean granitic gneiss complex to the S., and which grade into paragneiss and amphibolites to the N. "Two distinct groups have been recognized in the Cross Lake area: the Povungnituk, or lower, group and the Chukotat. The Povungnituk group consists of sedimentary and volcanic rocks, roughly in equal proportions, with gabbro sills. The Chukotat group is composed of volcanic rocks for the most part, with minor sedimentaries and with both gabbro and ultrabasic sills. An angular unconformity separates the 2 groups; a basal conglomerate is present above the unconformity in some localities, but is absent in others." The most outstanding structural feature in the area is a large open syncline plunging eastward from Cross Lake and continuing to the eastern border of the area. Folds and faults are briefly described. Sulfide minerals in the Cross Lake region include pyrrhotite, nickeliferous pyrrhotite, pentlandite, chalcopyrite, and pyrite. Three companies did exploration work on Ni-Cu deposits in 1957; their properties are briefly described. A small occurrence of asbestos-bearing serpentine 2 mi. S. of Cross Lake indicates the possibility of larger economic bodies in the region.--A. C. Sangree.

2-39. Moyer, Paul T., Jr. PRELIMINARY REPORT ON VERMETTE LAKE AREA (EAST HALF), SAGUENAY ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 397, 9 p., fold. geol. map (Prelim. Map no. 1286), scale 1:63,360, 1959, 2 refs.

The map-area (50°-$50^{\circ}15'$N. 67°-$67^{\circ}15'$W.) covers 192 sq. mi. W. and N. of Shelter Bay on the N. shore of the St. Lawrence River. Consolidated rocks are Precambrian; age relationships are difficult to determine. In order of abundance the rocks are: pink gneissic granite, pink granite gneiss, metasedimentary rocks and mixed gneisses, pink augen gneiss, pyroxene-hornblende-feldspar gneiss and possibly related dioritic rocks, and pegmatite and diabase dikes. Pleistocene ground moraine is widespread, and terraced fluvial deposits were noted along some of the lakes. Structure is complex. The 2 most readily identified structures are a northeasterly plunging anticline in the SW. corner of the map-area, and an elliptical basin structure NE. of the right-angle bend in Roches River. Joints are prominent. Evidence of faults is not apparent. Very minor magnetite mineralization was noted, and traces of sulfides are common, but no appreciable concentrations were found. --A. C. Sangree.

2-40. Rondot, Jehan. **PRELIMINARY REPORT ON MATAWIN-MÉKINAC AREA, LAVIOLETTE ELECTORAL DISTRICT: Quebec, Dept. Mines, Prelim. Rept. no. 395, 14 p., fold. geol. map (Prelim. Map no. 1268), scale 1:63,360, 1959, 6 refs.**

The map-area (46°45'-47°N. 72°37'30"-73°W.), mapped in summer 1958, lies along the St. Maurice River and comprises about 300 sq. mi. Consolidated rocks are considered to be Precambrian. Amphibolites, oldest rocks in the area, are always found as inclusions or as lenses in the other rocks. The paragneisses are included in the Grenville series. Among them are carbonate rock, quartzites, impure quartzite containing graphite and pink garnet, and fine-grained biotite-amphibole paragneiss. The impure quartzite is found in a thick fairly continuous bed. Metagabbros are associated with the paragneiss. The rocks have been strongly impregnated with green feldspathic material, and the resulting rock is a migmatite. Two contemporaneous granite stocks outcrop in the SE. part of the map-area. A second impregnation, consisting of pink quartzofeldspathic material in lit-par-lit injections, has affected the formations. Pegmatites are relatively abundant. In the eastern part of the area are dikes of pink granite (or aplite), aplite, and diabase. The fluvioglacial deposits mainly occupy the bottoms of the river valleys. Downstream from the confluence of the St. Maurice and Mékinac is a system of terraces, the oldest apparently dating from the encroachment of the Champlain Sea.

Structural history can be divided into 2 main phases. In the first, the formations were folded into a series of longitudinal folds and faults. Pressures were then exerted which resulted in a series of important breaks.

Deposits of Fe, Ti, molybdenite, and graphite are briefly described; also radioactive pegmatite occurrences and talc.--A. C. Sangree.

2-41. Sauvé, Pierre. **PRELIMINARY REPORT ON LEAF BAY AREA, NEW QUEBEC: Quebec, Dept. Mines, Prelim. Rept. no. 399, 10 p., fold. geol. map (Prelim. Map no. 1269), scale 1:63,360, 1959, ref.**

Leaf Bay area (58°30'-59°N. 69°-69°45'W.) covers approximately 750 sq. mi. on the SW. shore of Ungava Bay. It was mapped in summer 1958. Outcrops are fairly abundant, except in the eastern third of the area. The western half is underlain by metamorphosed sedimentary, basic volcanic, and basic intrusive rocks of the Labrador trough. "The metasedimentary rocks consist mainly of mica and garnet schists, but calcareous rocks, iron formation, and quartzite are also present in small amounts. Microcline gneisses are abundant in the eastern half of the area. They are associated with highly metamorphosed schists, iron formation, marble, and basic igneous rocks which are similar to, and may be of the same age as the rocks of the Labrador trough. Some of the microcline gneisses are similar in age to these schists, but some may be older and may belong to the 'crystalline basement' on which the 'trough' sediments were deposited. All these rocks are Precambrian." All the metamorphosed rocks are tightly folded. Longitudinal faults may be common, but their presence could not be demonstrated. The volcanic rocks are highly sheared, and longitudinal faults may be present in them. Transverse faults are indicated on aerial photographs. Iron formation occurs W. of the volcanic belt and to the N. and NE. of Ballantyne Lake. Eskers provide sources of sand and gravel that may become important when iron deposits are being brought to development.--A. C. Sangree.

2-42. Repenning, Charles A. **GEOLOGIC SUMMARY OF THE SAN JUAN BASIN, NEW MEXICO, WITH REFERENCE TO DISPOSAL OF LIQUID RADIOACTIVE WASTE: U.S. Geol. Survey, Trace Elements Inv. Rept. 603, 57 p., 13 maps (2 in pocket), 3 charts (2 in pocket), sec., diag. (in pocket), June 1959, 20 refs.**

The San Juan basin occupies about 20,000 sq. mi. of northwestern New Mexico and adjacent parts of Colorado. Parts of the area contain over 13,000 ft. of sedimentary rocks, of which a little less than half is of Paleozoic age. The Paleozoic rocks are approximately 55% siltstone, 30% limestone, and 14% sandstone with some evaporite deposits. They are largely of Pennsylvanian and Permian age, although Cambrian, Devonian, and Mississippian rocks are present.

In contrast to the Paleozoic rocks, the Mesozoic rocks of the San Juan basin are about half sandstone and half siltstone and claystone. Limestone and evaporites form a relatively insignificant part of the section. More than half of the Mesozoic rocks are of Cretaceous age and are of both marine and continental origin. Jurassic rocks contain proportionally greater amounts of continental deposits and the Triassic rocks include no known marine beds. The Cretaceous and Jurassic marine beds are primarily impervious claystone, siltstone, and sandy siltstone. The continental beds consist of intercalated sandstone and shale lenses.

Prediction of the lithology of most continental sequences at any specific point is virtually impossible without local field study. On the other hand the uniformity of marine lithologies is such that it may be predicted for any locality with a fair degree of certainty. Intermediate deposits, deposited in environments which may be grouped under the term "marginal marine," and including the most prominent sandstone units are of intermediate predictability as to their lithology at any specific point.

Tertiary rocks in the San Juan basin are exclusively continental. For the most part these rocks are lithologically comparable to the Mesozoic continental beds and are composed of intercalated sandstone and shale lenses.

Structurally, the San Juan basin resembles a northward tilted floor with steep walls along its N., E., and W. sides. Maximum relief along these walls occurs in the northern part of the area and decreases southward along the W. and E. sides. The southern side of the basin is not sharply defined. The basin structure was developed in Late Cretaceous and early Tertiary time and is divisible into several structural elements. Most oil and gas production is from the structural element referred to as the "central basin," which is the deepest part of the area. Most of the minor structures are concentrated in the structural element referred to as the area of "intermediate structures."

Four types of reservoirs in the San Juan basin appear to deserve consideration for possible storage of high-level liquid radioactive waste. These are in gypsum, limestone, shale, and sandstone. Gypsum appears more useful for the storage of sintered waste. Storage of liquid waste in limestone is possible, but it is uncertain whether the stored waste could be controlled. The construction of artificial reservoirs in shale units by hydraulic frac-

uring or deep-seated explosion has several advan-ages, the most significant of which is the relative certainty of confinement. Storage in permeable sandstone units is more favorable from the stand-point of heat control. --Auth.

2-43. Greig, Paul B. **GEOLOGY OF PAWNEE COUNTY, OKLAHOMA: Oklahoma Geol. Survey, Bull. 83, 188 p., 32 illus., 4 maps (1 col. geol. map under separate cover, scale 1 in. to 1 1/2 mi.), 8 secs. (3 under separate cover), 7 tables, Nov. 1959, 42 refs.**

This investigation is one of many similar investi-gations supervised by the University of Oklahoma School of Geology in cooperation with the Oklahoma Geological Survey in its program of mapping the sur-face geology of Oklahoma. Data were gathered in 7 months' field work during which 27 key beds were mapped on aerial photographs, and the lithology, thickness, sequence, and faunal content of the section were studied.

Sedimentary rocks of the Upper Pennsylvanian, Lower Permian, and Quaternary systems are exposed in Pawnee County. Pennsylvanian beds range upward from the Wann formation of late Missourian age to the Brownville limestone of latest Virgilian age. They are overlain with apparent conformity by a Permian sequence containing Wolfcamp sediments up to and including the Winfield limestone formation of the Chase group. Quaternary deposits and alluvium lie unconformably on the truncated edges of the Paleozo-ic strata.

During Late Pennsylvanian and early Permian time the Pawnee County area was situated between an eroding landmass to the S. and a cyclically subsiding marine basin to the N. The resultant sediments form a complex sequence transitional between the coarsely clastic continental deposits of the source area and the cyclic primarily marine deposits of the basin. Subdivision and classification of this transitional se-quence requires the use of nomenclature from both the marine and continental sections.

In late Missourian and early Virgilian time, de-position was controlled largely by conditions in the source area, and the rocks are mainly interbedded sandstones and shales of continental and deltaic ori-gin. Southward encroachment of a marine environ-ment and a concurrent decrease of source material are indicated in late Virgil and early Wolfcamp time by subcyclic deposition of sandstones, shales, thin limestones, and coals. A thick red bed sequence of late Wolfcamp age records rejuvenation of the source area and retreat of the sea, although a marine envi-ronment recurred periodically over much of the coun-ty during this time.

The subsurface strata are primarily of marine ori-gin and include beds of Cambro-Ordovician, Ordovi-cian, Mississippian, Pennsylvanian, and Permian age.

The sedimentary sequence contains 4 major angular unconformities and at least 4 minor unconformities. The westerly dip of the beds is interrupted locally by N.-trending belts of en echelon faults and small dome-like folds. Faulting and folding are attributed to hor-izontal and vertical movements, respectively, along ancestral zones of weakness in the granite basement. Folding took place recurrently throughout Pennsylvan-ian and early Permian time. The faulting probably occurred in late Permian or early post-Permian time, when the sediments were uplifted and tilted westward. The area was subsequently peneplaned and later re-juvenated. Dissection of the peneplane is currently in progress.

The county's chief mineral resource is oil. Poten-tially valuable deposits of clay and building stone and noncommercial deposits of coal, Cu, and radioactive minerals are known.--Auth.

2-44. Society of Economic Paleontologists and Mineralogists, Permian Basin Section. **GUIDEBOOK 1958 FIELD TRIP. CRETACEOUS PLATFORM AND GEOSYNCLINE, CULBERSON AND HUDSPETH COUNTIES, TRANS-PECOS, TEXAS: 90 p., 36 figs. incl. maps, secs., 9 tables, Van Horn, Texas, Apr. 10, 11, 12, 1959, 39 refs.**

The guidebook contains road logs of the route of the field trip, by Ronald K. DeFord, with notes on geology at each stop, accompanied by maps, sections, formation tables, etc. Contents are as follows:

Road Log from Van Horn to Assembly Point at Stop Number 1.

Stop Number 1: North of Kent.

Road Log from Stop Number 1 to Kent.

Road Log from Kent to Van Horn on U. S. Highway 80.

Stop Number 2: Boracho Point.

Road Log of Side Trip to Stop Number 3.

Stop Number 3: Black Peak.

Road Log, Van Horn to Wylie Mountains, Ocotillo Dome and Return.

Stop Number 4: Ocotillo Dome.

Road Log from Van Horn via Lobo Flat to Van Horn Mountains and Return.

Stop Number 5: Willoughby Windgap.

Road Log from Horn to Indio Mountains.

Stop Number 6: Indio Mountains.

2-45. North Texas Geological Society. **A GUIDE TO THE UPPER PERMIAN AND QUATERNARY OF NORTH CENTRAL TEXAS: 40 p., illus., maps, cross sec., log, table, Wichita Falls, Texas, Sept. 1959, refs.**

The guidebook was prepared for the fall meeting of the North Texas Geological Society, Sept. 26, 1959. It is an introduction to the present knowledge of the upper Permian and Quaternary surface deposits, with a brief review of some of the recent oil developments in Baylor, Knox, Foard, and Hardeman counties. Contents are as follows:

Road Log Covering Upper Permian and Quaternary of North Texas, p. 7-17.

Dalquest, Walter W. Pleistocene Deposits in Foard County, Texas, p. 18-19, 9 refs.

Swanson, Robert L. Rasberry Field, Foard County, Texas, p. 20-29.

Wayland, John Rex. Permian Oil Fields of North Texas, p. 30-34.

Scales, B. F. Copper and Gypsum Deposits of North-Central Texas, p. 35-38.

Bibliography on the Permian System of North Texas, p. 39.

2-46. Sanborn, Albert F., ed. **GUIDEBOOK TO THE GEOLOGY OF THE PARADOX BASIN: 308 p.,**

illus., maps (2 in pocket), charts, secs., diags., tables, [Salt Lake City, Utah], Intermountain Association of Petroleum Geologists, 1958, refs.

This guidebook was prepared for the Ninth Annual Field Conference of the Intermountain Association of Petroleum Geologists, Sept. 11-13, 1958. The following papers, maps, and road logs are included:

GENERAL PAPERS

Tank, R. W. Standard Nomenclature and General Stratigraphic Correlations in the Four Corners Area of the Paradox Basin, p. 9, 3 refs.

Eardley, A. J. Physiography of Southeastern Utah, p. 10-15, 2 refs.

Wilson, Bates E., and Lloyd Pierson. Arches and Natural Bridges National Monuments, p. 16-18, 5 refs.

Frost, John A. Canyons, Mystery and Solitude, p. 19-25, 11 refs.

Stokes, William Lee. Continental Sediments of the Colorado Plateau, p. 26-30.

Kelley, Vincent C. Tectonics of the Region of the Paradox Basin, p. 31-38, 16 refs.

Shoemaker, Eugene M., J. E. Case, and Donald P. Elston. Salt Anticlines of the Paradox Basin, p. 39-59, 37 refs.

Witkind, Irving J. The Abajo Mountains, San Juan County, Utah, p. 60-65, 8 refs.

Strobell, J. D., Jr. Salient Stratigraphic and Structural Features of the Carrizo Mountains Area, Arizona-New Mexico, p. 66-73, 15 refs.

Ekren, E. B., and F. N. Houser. Stratigraphy and Structure of the Ute Mountains, Montezuma County, Colorado, p. 74-77, 7 refs.

Lewis, Richard Q., Sr. Structure of the Elk Ridge-Needles Area, San Juan County, Utah, p. 78-85, 5 refs.

Joesting, Henry R., and Donald Plouff. Geophysical Studies of the Upheaval Dome Area, San Juan County, Utah, p. 86-92, 10 refs.

STRATIGRAPHIC PAPERS

Baars, D. L. Cambrian Stratigraphy of the Paradox Basin Region, p. 93-101, 14 refs.

Neff, A. W., and Silas C. Brown. Ordovician-Mississippian Rocks of the Paradox Basin, p. 102-108, 2 refs.

Wengerd, Sherman A. Pennsylvanian Stratigraphy, Southwest Shelf, Paradox Basin, p. 109-134, 15 refs.

Malin, William J. A Preliminary Informal System of Nomenclature for a Part of the Pennsylvanian of the Paradox Basin, p. 135-137, 3 refs.

Carter, Kenneth E. Stratigraphy of Desert Creek and Ismay Zones and Relationship to Oil, Paradox Basin, Utah, p. 138-145, 9 refs.

Linscott, Robert O. Petrography and Petrology of Ismay and Desert Creek Zones, Four Corners Region p. 146-152, 11 refs.

Welsh, John E. Faunizones of the Pennsylvanian and Permian Rocks in the Paradox Basin, p. 153-162 2 refs.

Kunkel, Robert P. Permian Stratigraphy of the Paradox Basin, p. 163-168, 16 refs.

Robeck, Raymond C. Chinle and Moenkopi Formations, Southeastern Utah, p. 169-171, 9 refs.

Wright, J. C., and D. D. Dickey. Pre-Morrison Jurassic Strata of Southeastern Utah, p. 172-181, 24 refs.

Craig, Lawrence C., and Robert A. Cadigan. The Morrison and Adjacent Formations in the Four Corners Area, p. 182-192, 24 refs.

Katich, Philip J., Jr. Cretaceous of Southeastern Utah and Adjacent Areas, p. 193-196, 11 refs.

ECONOMIC PAPERS

Miscellaneous

Grundy, W. D., and E. W. Oertell. Uranium Deposits in the White Canyon and Monument Valley Mining Districts, San Juan County, Utah, and Navajo and Apache Counties, Arizona, p. 197-207, 5 refs.

Wood, H. B., and M. A. Lekas. Uranium Deposits of the Uravan Mineral Belt, p. 208-215, 13 refs.

McGinley, Frank E. An Introduction to Uranium Ore Processing, p. 216-220, 2 refs.

Hite, Robert J., and W. C. Gere. Potash Deposits of the Paradox Basin, p. 221-225, 6 refs.

Oil and Gas

Picard, M. Dane. Subsurface Structure, Aneth and Adjacent Areas, San Juan County, Utah, p. 226-230, 6 refs.

Dahm, John N., and others, rev. by P. K. Low. Penetration Chart of Oil and Gas Fields in Utah, facing p. 230.

Chambliss, G. F., and J. L. Hallman. Logging and Correlation Techniques in the Paradox Basin, p. 231-234.

MacAlister, R. S., Jr. How Oil Wells Are Made in the Paradox Basin, p. 235-237.

Heylmun, Edgar B. Oil and Gas Possibilities Around the Laccolithic Type Intrusions in the Colorado Plateau, p. 238-240, 9 refs.

Fehr, George D., and J. R. Williams. Oil and Gas Leasing in the Paradox Basin, p. 241-244.

Lockridge, J. P. Alkali Gulch Gas Field, La Plata County, Colorado, p. 245-246.

Quigley, W. Don. Aneth Field and Surrounding Area, p. 247-253.

Carlton, P. E. Geology and Drilling History of the Big Flat-Cane Creek Area, Grand County, Utah, p. 254-256.

Conner, D. C., and Edward M. Wright, Jr. Bluff Field, p. 257-261, 4 refs.

Sheffer, B. Douglas. Boundary Butte Area, San Juan and Apache Counties, Utah and Arizona, p. 262-267, 7 refs.

Turner, Tom E. Chinle Wash Structure, San Juan County, Utah, p. 268-270, 2 refs.

Howard, E. L., and R. S. Brown. Geology of the Coal Bed Canyon Structure, p. 271-274.

Lauth, Robert E. Desert Creek Field, San Juan County, Utah, p. 275-277.

Carr, W. E., and J. C. White. The Ismay Oil Field, p. 278-279.

Vaughan, Richard H. North Toh-Atin Gas Field, Apache County, Arizona, p. 280-281.

Robinson, B. B. Ratherford Field, San Juan County, Utah, p. 282-285, ref.

Carter, Kenneth E. Turner Bluff Field, San Juan County, Utah, p. 286-287.

Fenex, W. D., and Charles V. Lee, Jr. White Mesa Field, p. 288-289.

OAD LOGS

Elias, Gregory K., and Don Baars. First Day - hursday, Sept. 11, 1958, Moab, Utah, to Elk Ridge, . 291-297.

Eicher, L. J., and W. A. Beauclair. Second Day - riday, Sept. 12, 1958, Elk Ridge, Utah, to Monu- ent Valley, Arizona, p. 298-304.

Carr, W. E., and R. Nelson. Third Day - Satur- ay, Sept. 13, 1958, Monument Valley, Arizona, to neth Oil Field, Utah, p. 305-308.

APS

Taylor, Robert K., and Jack R. Century. Geologic ap of Southeastern Utah, Paradox Basin (2 parts), pocket, scale 1 in. to 3 1/2 mi.

Hague, R. S., S. J. Goldenstein, and E. Blakey. ranium-Vanadium Deposits of the Uravan Mineral elt, in pocket, scale 1 in. to approx. 10,000 ft.

-47. Williams, Norman C., ed. **GUIDEBOOK TO HE GEOLOGY OF THE WASATCH AND UINTA OUNTAINS TRANSITION AREA**: 235 p., illus., aps (2 in pocket), charts, secs., diags., tables, Salt Lake City, Utah], Intermountain Association of etroleum Geologists, 1959, refs.

This guidebook was prepared for the Tenth Annual ield Conference of the Intermountain Association of etroleum Geologists, Sept. 10-12, 1959. The area f the Wasatch and Uinta mountains is transitional in any respects. The great thrust zone or disturbed elt which serves to divide 2 structurally dissimilar egions transects the area, the sedimentary transi- ion from miogeosynclinal to shelf type deposits is vident in many of the stratigraphic units, and sever- l physiographic provinces and subprovinces merge ne into the other within the area. Historical, geo- raphical, and economic summaries are included to ive greater understanding of the area. --From ed. oreword.

The following papers and road logs are included n this guidebook:

APERS

Miller, David E. An Historical Sketch of the Area, . 1-7, 6 refs.

Hawkes, H. Bowman The Back Valleys of Summit nd Wasatch Counties, p. 8-18, 13 refs.

Murdock, J. Neil. Water Resources, p. 19-23.

Threet, Richard L. Geomorphology of the Wa- atch-Uinta Mountains Junction, p. 24-33, 23 refs.

Cohenour, Robert E. Precambrian Rocks of the inta-Wasatch Mountain Junction and Part of Central tah, p. 34-39, 20 refs.

Lochman-Balk, Christina. The Cambrian Section the Central and Southern Wasatch Mountains, . 40-45, 24 refs.

Hintze, Lehi F. Ordovician Regional Relation- hips in North-Central Utah and Adjacent Areas, . 46-53, 42 refs.

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GEOLOGIC MAPS

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2-48. Dietrich, Richard V. GEOLOGY AND MINERAL RESOURCES OF FLOYD COUNTY OF THE BLUE RIDGE UPLAND, SOUTHWESTERN VIRGINIA: Virginia Polytech. Inst., Bull., v. 52, no. 12, (Eng. Expt. Sta. Ser. no. 134), 160 p., 48 illus., 5 maps, (1 fold., scale 1 in. to 2 mi.), profile, 2 tables, Oct. 1959, 176 refs.

Floyd County is located in southwestern Virginia at the northeastern end of the Blue Ridge upland. Much of the county is readily accessible from the Blue Ridge Parkway, Virginia highways 8 and 221, and many miles of county roads.

The topography and drainage of the county are of particular interest because the county includes part of the boundary between the 2 more or less distinct parts of the Blue Ridge province - the irregular mountain ridges drained by Atlantic Coast streams and the dissected upland drained almost wholly by streams of the Gulf of Mexico drainage basin. Evidence here suggests that the location, as well as the character, of the present Blue Ridge escarpment is the result of migration of the asymmetric Atlantic-Gulf divide - if an ancestral escarpment formed by faulting, or any other local control, ever did exist, it must have been far SE. of the present escarpment. Evidence also indicates that this part of the Blue Ridge upland was reduced to maturity at least once in the past. Because the surface was drained to the W. at that time just as it is today, it is considered impossible with data now available to correlate it with any of the so-called Appalachian "peneplanes" which were drained to the E. Data and ideas presented are fitted into a general geomorphological history suggested for the province for the time subsequent to the late Paleozoic (?) establishment of New River.

The following rocks underlie most of Floyd County: 1) Little River gneiss - chiefly a highly sheared blue quartz augen gneiss plus or minus feldspar augen, 2) "Lynchburg" gneiss - mica schist-gneiss, 3) Willis phyllite - a highly crenulated garnet-bearing phyllite, 4) Alum phyllite - chiefly a sericitic slate-phyllite, and 5) diverse amphibole-rich rocks. The phyllites and amphibole-rich rocks occur within or grade into the "Lynchburg" formation. Relatively smaller areas are underlain by rocks such as hypersthene granodiorite and granitic gneisses of the Blue Ridge "complex," soapstone within the "Lynchburg" formation area, essentially unmetamorphosed clastic sedimentites of the Precambrian-Cambrian (?) Unicoi and Hampton formations and of the early Middle Cambrian Rome formation, numerous quartz veins, and gossans. All rocks except those of the Unicoi, Hampton, and Rome formations have been notably metamorphosed. Of particular petrological interest are the highly sheared rocks, some of the porphyroblastic rocks, the amphibole-rich rocks, and the Little River gneiss whose origin involves problems related to magmatism versus "granitization." "Absolute," relative, and geologic age data suggest that the Little River gneiss and the rocks mapped as belonging to the "Lynchburg" formation once belonged to the same sedimentary sequence and are of pre-late Precambrian age (it is because of this that Lynchburg is used in quotes - the rocks may not be correlative with type locality Lynchburg formation rocks.); that the amphibolites that represent intrusives are probably of the same general age as the amphibole-rich foliates intercalated with the "Lynchburg" metasedimentites; that the Unicoi and Hampton are post-Blue Ridge "complex" rocks and pre-lower Middle Cambrian(?); and, that the Rome formation is lower Middle Cambrian in age.

The structure of the rocks of Floyd County is extremely complex and most features are subject to more than one interpretation. According to interpretations favored herein most of the rocks of the county are involved in plunging, nearly isoclinal folds. From N. to S. the major structures are: a southeasterly dipping fault along which metamorphic rocks of the "Blue Ridge Anticlinorium" are thrust over folded sedimentary rocks of the Valley and Ridge, a syncline involving the Alum phyllite and parts of the Little River gneiss and the "Lynchburg" mica schist-gneiss, an anticline involving the Willis phyllite and part of the "Lynchburg" schist-gneiss, and unnamed folds, for example a nearly vertically plunging fold involving the "Lynchburg" and some of the intercalated amphibole-rich rocks S. of the village of Floyd. A structural depression trends roughly N.-S. through the center of Floyd County. Buffalo Mountain in the southwestern part of Floyd County constitutes part of a cross structure that strikes approximately N. 60°W. and plunges to the SE. Of particular interest are the facts that what is generally considered "basement" was involved in a major fault and that at least part of the metamorphism in the area was synchronous with deformation. An attempt is made to fit the petrologic and structural "facts" and interpretations into a geologic history for the area.

There is no mineral production in Floyd County at the present time. In the past, As, Cu, Au, Fe, asbestos, dimension stone, and crushed stone have been produced in at least small quantities. Ni, Co, S, rutile, graphite, quartz crystals, feldspar, slate (both for roofing and for preparation of lightweight aggregate) and vermiculite have been considered by some persons to be present in possibly economic quantities. Only crushed stone for use as road metal, and this strictly for local use, has assured future production. If a real need for As presents itself in the future the abandoned Brinton mine should be explored further. The Toncrae sulfide deposit constitutes a fairly large reserve of S and Fe with minor Cu. The Tices Mill sulfide deposit is considered to be worth further exploration of the "wildcat" type. Some shales and mudstones of the Rome formation constitute possible sources for lightweight aggregate raw material.--Auth.

2-49. Kaye, Clifford A. GEOLOGY OF THE SAN JUAN METROPOLITAN AREA, PUERTO RICO: U.S. Geol. Survey, Prof. Paper 317-A, p. 1-48, 13

illus., 4 maps (2 maps in pocket, scales 1:30,000 and 1:240,000), chart, sec., 1959, 44 refs.

The San Juan area comprises about 80 sq. mi. centered about the city of San Juan. It consists of a northern gently sloping coastal plain, broken by several steep-sided hills, and a southern low to moderate hilly upland. The uplands are underlain by a sequence, 16,000 ft. or more thick, of deformed rock, varying from Late Cretaceous to late Paleocene, or early Eocene, in age (the older complex), and consisting of volcanic, tuffaceous, and sedimentary rocks and shallow to hypabyssal intrusives. These rocks represent accumulations on the flanks of a large volcanic cone, which rested on a foundering crust and was probably entirely overlapped by marine deposits. Rocks of early Miocene age unconformably overlie the older complex. They are about 3,000 ft. thick but thicken to the N. Older alluvium, consisting of decomposed sand and gravel blankets part of the upland and much of the coastal plain. Littoral deposits of Pleistocene age, consisting of cemented dunes and interbedded shallow marine and beach deposits, crop out on Isla San Juan, Santurce, and offshore islets.

All older complex rocks show mineralogic changes indicative of low-grade regional metamorphism. Some igneous textures show evidence of having resulted from alterations of sedimentary rocks in place. The older complex has been deformed into several large, fairly symmetrical flexures, mainly striking E. Faults abound. A large N.-dipping thrust crosses the area and has an estimated horizontal displacement of over 3 mi. The larger high angle faults have 2 dominant trends: WNW. and ENE. Movement along some of these faults probably occurred up into Pleistocene time. The orogeny that deformed the older complex took place during the late Paleocene or Eocene. Coarse-grained alluvium of basal middle-Tertiary deposits show that Puerto Rico had a rugged topography in the late Oligocene. Downwarping on both the N. and S. of an E.-W. axis occurred at this time, and this geanticlinal structure has dominated the structural deformation of the island ever since. The properties of the several formations for use in foundations, as a source of construction material, and other engineering applications are discussed.--Auth.

2. GEOMORPHOLOGY

See also: Geologic Maps 2-3, 2-4, 2-11; Geochemistry 2-187; Engineering Geology 2-247.

2-50. Weeks, Wilford F., and Owen S. Lee. OBSERVATIONS ON THE PHYSICAL PROPERTIES OF SEA-ICE AT HOPEDALE, LABRADOR: Arctic, v. 11, no. 3, p. 134-155, 6 illus., map, 4 profiles, 3 diags., 8 graphs, 1958, pub. 1959, 13 refs.

The formation of a sea-ice cover under subarctic conditions is described, and changes in the salinity, temperature, ice accumulation rate, and density of the ice sheet are measured. A layer of slush commonly forms in the lower part of the snow cover on top of the sea ice after periods of near freezing air temperatures. This slush layer is caused by the migration of intergranular brine from the sea ice and sea water upward into the snow under hydrostatic pressure resulting from the depression of the ice sheet by the weight of the snow. Plots of the variation of snow and slush density with time are presented. The top of the slush layer is in general above the theoretical water level showing that capillary action is an important factor in determining the thickness of the layer. Freezing of the slush layer forms an equigranular fine-grained ice with pronounced vertical C-axis orientation which contrasts with the columnar texture and horizontal C-axis orientation of normal sea ice. Freezing of the slush layer also causes irregularities in plots of the average salinity of the ice sheet and accumulated degree-days of cold against the thickness of the ice sheet. After the period of slush formation an extreme scatter develops in the ice thickness with the maximum ice thickness occurring beneath deep snow drifts. The resulting ice thickness is about 20% greater than would be expected from projecting known sea-ice growth curves.--W. F. Weeks.

2-51. Patenaude, Robert W., E. W. Marshall, and Anthony Gow. DEEP CORE DRILLING IN ICE, BYRD STATION, ANTARCTICA: U.S. Snow, Ice & Permafrost Research Establishment, Tech. Rept. 60, 7 p., 2 diags., 4 tables, 1959.

This paper is divided into 2 sections: Part I. Drilling Techniques, by R. W. Patenaude, and Part II. Core Examination and Drill Hole Temperatures, by E. W. Marshall and A. Gow.

The preliminary results of core examinations and drill-hole temperature studies Nov. 1957-Jan. 1958 are reported, and the drilling equipment and techniques are described. Drilling was accomplished with a Failing model 314 rotary skid-mounted well-drilling rig with a 38-ft. mast, powered by a 43-b. hp. Buda gasoline engine. Two types of bits, both cutting a 3 7/8-in. core and a 5 3/4-in. hole, were used. The speed of rotation was varied from 40-75 r. p. m., and the rate of penetration ranged from 2.5-10 in./min. Compressed air was used as the drilling fluid. Good quality cores were obtained down to 1,013 ft. with a 98% recovery. Examination of the cores revealed the presence of a detailed stratigraphic sequence down to a depth of 400 ft., consisting of alternating layers of coarse- and fine-grained snow associated with ice bands 4 mm. thick, which appeared singly or in closely spaced groups at regular intervals. Below this depth the ice was very homogeneous, except for thin ice bands which persisted to the bottom. The mean densities for meter increments to a depth of 150 ft., densities determined from spot samples at 5 points from 400 - 721.5 ft., and drill-hole temperatures down to 1,000 ft. are tabulated. --Auth. summ.

2-52. McCutchen, W. T., and William F. Tanner. SERPENTINE MEDIAL MORAINES ON MODEL GLACIER: Geol. Soc. America, Bull., v. 70, no. 11, p. 1487, illus., Nov. 1959, 2 refs.

A model is described that is designed to duplicate the serpentine pattern of medial moraine on the Malaspina Glacier. A working hypothesis was adopted that differential flow from multiple reservoirs produces the serpentine pattern.--B. W. Pipkin.

2-53. Mason, Robert W. THE McCALL GLACIER PROJECT AND ITS LOGISTICS: Arctic, v. 12, no. 2, p. 77-81, 2 illus., map, June 1959.

In Aug. 1956 a search began for a suitable glacier that would lend itself to a glacial-meteorological project established by the United States IGY Glaciological Panel. It was hoped to find a valley glacier in the highest area of the Brooks Range, northern Alaska, about 144°W. 69°30'N., that was fairly accessible. An air search revealed McCall Glacier, "a slender valley glacier with a gentle gradient, no ice falls, limited crevassing, and no tributary cirque glaciers." The glacier could be approached on foot from a low camp on the tundra, a light ski plane could probably land on the glacier, and vehicles might be able to get up the valley.

The procedure of establishing camps and arranging for supplies and instruments for the 4-man party is described. By June 15, 1957, the 2 glacier camps were established, micrometeorological instruments were installed and operating, and radio contact with nearby radio stations was made. With a 3-month supply of fuel and rations cached at the camps, the scientific program was under way.--L. M. Dane.

2-54. Sater, John E. GLACIER STUDIES OF THE McCALL GLACIER, ALASKA: Arctic, v. 12, no. 2, p. 82-86, 3 illus., June 1959.

McCall Glacier, Brooks Range, northern Alaska, was studied in 1957. It covers about 5. 12 sq. km., filling about two-thirds of its drainage basin. The highest reaches of the ice are on the N.-facing walls of the upper valley in cirques more than 2,700 m. above sea level. From the confluence of the cirques the ice drops in 8 broad steps to the terminus at 1,250 m. The ice surface is composed of elongate hummocks 0. 3 to 2 m. long. Most of the glacier is covered with a mantle of dust, rock, and boulders, many of which melt into the ice and give it a pock-marked surface. Surface runoff from the cirques appears to flow into 2 main outlets, a marginal stream and a circular fissure at the head of the glacier trunk. There are 2 principal areas of crevassing other than the ice faces above the cirques and the bergschrunds. The largest crevasse explored was 5 m. across at the widest part, 60 m. long, and an estimated 25 m. deep. The majority of large crevasses in the trunk have widths up to 1 m. Blue bands are quite frequent in the glacier and are apparently random in their orientation. Dirt-filled shear planes are also quite common. Data collected included continuous records of long and short wave energy gain and loss, air temperature, and wind speed. Snow pits have been dug at regular intervals to a depth of 2. 5 m. to study stratigraphy of the snow and behavior of the firn. Temperatures to a depth of 100 m. were recorded periodically, and ice motion studies were made.--A. C. Sangree.

2-55. Keeler, Charles M. NOTES ON THE GEOLOGY OF THE McCALL VALLEY AREA: Arctic, v. 12, no. 2, p. 87-97, 5 illus., map, June 1959, 5 refs.

In summers 1957 and 1958 the writer studied that part of the McCall Valley (Brooks Range, northern Alaska) between McCall Glacier and the Jago River. The valley walls rise about 450 m. from floor to ridge top, with an average slope of 30°. The valley floor is covered with stream-carried debris of boulder size and patches of clay and silt.

Bedrock consists of a sequence of N.-dipping sediments (Lisburne limestone, probably Upper Mississippian; Sadlerochit formation, Permian) abutting against a granite mass of about 650 sq. km. in area. Contact between sediments and granite is believed to be a normal fault. The granite is part of a small batholithic mass with predominant composition in the McCall area of quartz, microcline feldspar, and biotite, with traces of muscovite, galena, and molybdenite. Both pegmatite and aplite dikes are found. Age of the granite has not been determined, but it cannot be pre-Mississippian. Both sediments and granite are much sheared, and there is strong cleavage trending NE. Sediments N. of the granite are locally folded and overturned.

Evidence of multiple glaciation of the alpine-valley type is fairly abundant. Five advances of the McCall Glacier are marked by lateral and end moraines in the lower part of the valley and by trimlines and truncated spurs in the upper part. The advances and their deposits are briefly described. Correlation may be made of the glacial sequence here with that of the central Brooks Range. No material suitable for C^{14} dating was found.

The nature of unconsolidated sediments in the McCall Valley is unfavorable for extensive development of patterned ground. Some polygons, small stone steps, stone circles, and small solifluction lobes were noted. A rather extensive aufeis field has developed below the terminus of the McCall Glacier and extends for 400 m. downstream.--A. C. Sangree.

2-56. Blackadar, Robert G. PATTERNS RESULTING FROM GLACIER MOVEMENTS NORTH OF FOXE BASIN, N.W.T.: Arctic, v. 11, no. 3, p. 156-165, 5 illus., 2 maps, 1958, pub. 1959, 4 refs.

Foxe Basin, a relatively shallow sea, is bounded on the N. and E. by Baffin Island, on the W. by Melville Peninsula, and opens on the S. into Hudson Bay. A study of air photographs in conjunction with a geological survey disclosed many well-defined features such as glacial flutings, drumlinoid ridges, crag and tail structures, and eskers. Raised beaches were also seen to be extremely common.

N. and W. of Fury and Hecla Strait the latest ice movement was from the NE.; S. of the strait the trends are E.-W. Patterns in the vicinity of Steensby Inlet indicate that it channeled the ice; patterns E. of the inlet are NE.-trending, whereas those to the W. are NW.-trending.

Raised beaches were found as high as 600 ft. above present sea level and marine shells at 430 ft. The rate of emergence of Igloolik Island, based on a radiocarbon date of 1750 B. C. $\pm$ 300 years obtained by J. Meldgaard, a Danish archeologist, on material from a 51-m. beach, is about 4. 5 ft. per century. This rate cannot be applied to all parts of the district.--Auth.

2-57. Allen, Victor T. GUMBOTIL AND INTERGLACIAL CLAYS: Geol. Soc. America, Bull., v. 70, no. 11, p. 1483-1485, Nov. 1959, 12 refs.

This study is directed toward Lougee's concept that gumbo clays are subaqueous deposits resulting from a single Pleistocene glaciation in Europe and America. Thin sections of 10 completely oriented vertical profiles of the weathered zones of drift sheets in Illinois, prepared for a prior investigation, were restudied in view of Lougee's concepts. Petrographic study of gumbotil shows the edges of feldspar grains altered to clay minerals and shows feldspars that extinguish as a single grain but are so cut by veins and patches of clay that they could not have been transported in this condition. Ferromagnesian

inerals are similarly affected in the weathered ones. The percentage of heavy minerals in decomosed till is lower, the loss being chiefly those inerals that perish easily. The evidence strongly upports Kay's conclusion that gumbotil is the result f chemical weathering during interglacial stages. he processes suggested by Lougee will not explain he features observed in the weathered zones of lacial deposits or gumbotil.--B. W. Pipkin.

-58. Gamble, Erling E. DESCRIPTIONS AND NTERPRETATIONS OF SOME PLEISTOCENE ECTIONS IN WAYNE COUNTY, INDIANA: Earlham oll., Sci. Bull. no. 3, 41 p., 10 figs., Dec. 1958, 8 refs.

This paper is the result of a study of the Pleistoene stratigraphy of approximately a 6 sq. mi. area mmediately SE. of the town of Centerville, Wayne ounty. The sections are exposed in undercut banks ormed by streams impinging against the valley sides. teep, fresh exposures of the glacial deposits in these laces range up to 60 ft. high.

Data from 8 sections and from 5 water well ecords (as obtained from drillers) are discussed. has been determined that in the area studied, the tratigraphic sequence includes deposits of the linoian, Sangamonian, and Wisconsinan stages. here appear to have been at least 4 oscillations of he ice in the study area during both Illinoian and Visconsinan time.

The evidence for the Sangamonian interglacial age s the presence of a highly weathered soil, buried in he glacial drift. Well preserved examples of this uried soil are found in 2 of the sections, and posible remnants are found in 2 others. Also, 3 of he water well records show a thick oxidized zone, uried beneath unoxidized drift, that is believed to e a correlative of the buried soil exposed in the ections.

The Illinoian drift consists of 4 layers of calcarous till separated by layers of calcareous sand and ravel. There is no evidence of an extended time nterval between these advances, so they are considred to represent local fluctuations of the ice front. owever, a calcareous silt, rich in plant remains nd snail shells, lying on top of the oldest Illinoian ll, indicates that there was a retreat from the udy area during the Illinoian glacial age sufficient- long for plants and animals to become established.

There is no evidence of a significant time interval etween the ice fluctuations that laid down the 4 Visconsinan tills in the area, although between the ottom 2 Wisconsinan tills and beneath the upperost Wisconsinan till, snail- and plant-bearing alcareous silt units exist.

A gravel, sand, and silt unit, found in the lower art of the Illinoian drift, is an excellent aquifer over wide area in and around the study area. This unit rovides a copious flow of water in the streams the ear around. It is the source of water in 3 of the wells whose records were obtained. The evidence dicates that in the study area a dependable supply water may be obtained from this stratigraphic nit by drilling about 100 ft. below the upland surce.

The formation and character of the gullies that ut back into the upland from the major streams of e area are influenced by the sand and gravel units andwiched between the layers of till. When one of ese nonresistant layers is cut into, rapid headward rosion results from the ready removal of the sand nd gravel and subsequent caving of the overlying material. This produces a deep, steep-sided gully whose new depth is controlled by the gravel layer. Where more than one sand layer is involved the gully bottom has a steplike profile.

The present surface soils in the study area, developed on the uppermost Wisconsinan till seen in the described sections, belong to the Miami Catena.--Auth.

2-59. Harrison, W. PETROGRAPHIC SIMILARITY OF WISCONSIN TILLS IN MARION COUNTY, INDIANA: Indiana, Geol. Survey, Rept. Prog. 15, 39 p., 5 figs., 4 tables, 1959.

Two to 4 till sheets were deposited in Marion County by the East White sublobe of the Ontario-Erie major lobe of the Wisconsin ice sheet. Fraction analyses (mineralogy and lithology versus size) were made for 11 till samples from 4 outcrop localities near the corners of Marion County. The composition of each of 16 Wentworth size fractions (between 0 and 32 mm.) was determined for each sample. True weight relationships were obtained from the particle-frequency data following experimental determination of the average grain weight for each mineral and rock type in a given size fraction. The fraction analyses were then expressed in weight percent.

Correlation of till samples from the 4 outcrop localities was attempted according to these assumptions: 1) parts of at least 1 formerly continuous till sheet are present in Marion County, 2) remaining segments of this till sheet crop out at the 4 localities chosen for study, 3) individual till sheets are homogeneous and distinguishable one from another, and 4) a given till sheet can be ascertained by finding the group of 4 samples (1 from each outcrop locality) that shows the highest degree of textural and/or compositional similarity.

Plotting of the fraction-analysis data on triangular diagrams indicates that the 11 till samples are too similar in texture and composition to satisfy assumption 4), and it is probable that assumption 3) is invalid. The pronounced textural and compositional similarity of the till samples implies uniformity of glacial processes throughout the area of investigation and suggests but slight variation in the materials of the source area between successive glaciations.--Auth.

2-60. Shepps, Vincent C., George W. White, John B. Droste, and Robert F. Sitler. GLACIAL GEOLOGIC MAP OF NORTHWESTERN PENNSYLVANIA: Pennsylvania Geol. Survey, Bull. G-32, 59 p., 11 figs., map scale 1:62,500, 1959, 62 refs.

Northwestern Pennsylvania is covered with deposits of drift brought by continental ice sheets which invaded from the N. and NE. Ice moved down the Erie basin as a major lobe known as the Erie lobe and spread out into northwestern Pennsylvania twice during the Illinoian age and 5 times during the Wisconsin age of the Pleistocene epoch. Tills of the various advances are identified and separated into stratigraphic entities on the basis of leaching, texture, color, and soil profile development and are treated as rock-stratigraphic units.

The outermost drift of northwestern Pennsylvania is Illinoian in age and extends as to a 2- to 14- mi. wide band from Beaver County at the Ohio-Pennsylvania border to Warren County at the New York border. Two drifts are found in this belt, an outer drift represented by very thin, discontinuous till and erratics, and an inner (younger), thin, but more

continuous fine-grained till. The Wisconsin drifts are Tazewell and Cary in age, but Tazewell drift was completely covered by later Cary drift and does not appear at the surface.

Still farther to the N. and parallel to the southern shore of Lake Erie is the Ashtabula morainic system, a series of en echelon end moraines composed of silt till and deposited by the Ashtabula advance, the last advance of Cary time and the last ice to enter Pennsylvania. The Ashtabula moraines override the Defiance moraine in part. Lake deposits laid down after the Ashtabula ice had retreated blanket the plain S. of present Lake Erie.--Auth.

2-61. Beaty, Chester B. SLOPE RETREAT BY GULLYING: Geol. Soc. America, Bull., v. 70, no. 11, p. 1479-1482, map, diag., Nov. 1959, 9 refs.

The mechanisms of slope retreat are varied and subject to but a few generalizations within limited areas. This study reports the results of an investigation of gullying in the White Mountains of eastern California and western Nevada. On lower White Mountain slopes smooth segments are being carved by gullies, and the slopes are retreating essentially by this process. There is little evidence that gullies and ridges change position cyclically as has been suggested. Evidence indicates that gullies continue to deepen, and intergully ridges are lowered at a roughly comparable rate. During heavy rains, water collects in the gullies and flushes out debris accumulated from adjacent ridges. During the long periods between heavy rains, weathered material is shifted to the gully floor from the ridges, and the slope is smoothed. The total morphological effect of a completed cycle is a lowering of the entire slope surface. All gully systems had a parallel arrangement of furrows and were found on slopes as high as 35^{o}. Gullying is only one process at work in the White Mountains and, although visually spectacular, is perhaps no more important than other mechanisms of slope retreat.--B. W. Pipkin.

2-62. Fraser, J. Keith. FREEZE-THAW FREQUENCIES AND MECHANICAL WEATHERING IN CANADA: Arctic, v. 12, no. 1, p. 40-53, 2 maps, 6 graphs, 2 tables, March 1959, 19 refs.

The repeated freezing and thawing of water is recognized as an important factor in the mechanical weathering of rock. References to frost-riven rock in arctic regions imply that such predominant rock disintegration is characteristic of high latitudes simply because low temperatures and repeated freezings occur there. Meteorological records are used to examine and compare the frequency of freeze-thaw (F/T) cycles in middle and high latitudes in Canada.

Recognizing the limitations of screen versus ground temperatures, short term records, and arbitrary limits of effective freeze and thaw, the study indicates that average annual frequencies of F/T cycles increase steadily from N. to S. in central Canada. The variation in annual F/T frequency regimes is illustrated by graphs of 20 Canadian stations. Graphs of daily temperatures for 1949 show the contrast between Regina, Saskatchewan (50°27'N.) and Eureka, N. W. T. (80°00'N.). A simple regression curve equation allows a rough prediction of F/T frequency for a particular station from a knowledge of the diurnal range.

While accepting the concept of predominant mechanical weathering in high latitudes, it is suggested that the evident abundance of shattered rock derives from the absence of a concealing and insulating mantle of snow, soil, and vegetation characteristic of lower latitudes.--Auth.

2-63. Hickox, Charles F., Jr. FORMATION OF VENTIFACTS IN A MOIST, TEMPERATE CLIMATE: Geol. Soc. America, Bull., v. 70, no. 11, p. 1489-1490, 2 illus., map, Nov. 1959, ref.

Ventifacts have been found in the central portion of Annapolis Valley, Nova Scotia. The average annual rainfall for the valley is 41.41 in. The ventifacts are restricted to the surface of an esker delta that rises about 30 ft. above the onlapping sediments of the outwash plain. The internal structure of the delta, exposed in a number of sand pits, consists of cross-laminated beds of well-sorted, medium-grained sand with rare lenses of water-worn pebbles. Because of excessive drainage the upper third of the ridge is unvegetated sand. The pebbles have been modified from their original subrounded or subspherical shape into faceted and keeled ventifacts. The ventifacts are surficial, and it is inferred that they were formed in modern times. Evidence is presented demonstrating that ein-, zwei-, and dreikanters were cut on vein quartz, quartzite, and indurated sandstone in less than 10 years. Prevailing wind and a windward source of sand are the only requirements for the abrasion of ventifacts. Wind-abraded stones may form in a moist, temperate climate; they do not necessarily indicate arid or proglacial environments.--B. W. Pipkin.

2-64. Shaw, T.R. FOR THE RECORD: Natl. Speleol. Soc., Bull., v. 21, pt. 1, p. 33-42, table, Jan. 1959, approx. 67 refs.

The depth and lengths of caves are controversial subjects. To date the greatest known depth is 3,680 at Gouffre Berger in France. Fourteen other European caves are over 1,400 ft. deep. In America the deepest cave is Neff Canyon Cave, 1,186 ft., followed closely by Carlsbad Cavern, 1,070 ft. The longest mapped cave is Hölloch in Switzerland, 37.6 mi. Mammoth Cave in the United States has 33 mi. mapped and has a total passage length in the order of 100 mi. Crystal Cave, Kentucky, has about 23 mi. mapped and is a rival to Mammoth in size. --Auth.

2-65. Halliday, William R. HOLOCRYSTALLINE SPELEOTHEMS: Natl. Speleol. Soc., Bull., v. 21, pt. 1, p. 15-20, 8 illus., Jan. 1959, 4 refs.

Dripstone speleothems which display characteristics of a single crystal have been found in several caves in Texas and California. Two forms, externally holocrystalline and internally holocrystalline, exist. The former are generally tubular in form; the latter are sometimes solid, lacking an open central canal. The internally holocrystalline forms fracture obliquely across the stalactite on a single face. Internally holocrystalline speleothems possibly are formed by internal flow and recrystallization. --Auth.

2-66. Myers, Arthur J. AN AREA OF GYPSUM KARST TOPOGRAPHY IN OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 1, p. 10-14, illus., 2 maps, Jan. 1960, ref.

An area of gypsum karst topography occurs in the

Blaine formation (Permian) in northeastern Woodward County, Oklahoma. It is not an ideal karst because of interbedded shales, but sinks, streams draining into sinks, and caves are common in a belt paralleling the Cimarron River. Included are specific locations of all karst features and a geologic map and stereo pair of the Alabaster Caverns State Park area. --Auth.

2-67. Ingalls, Huntley. THE EXPLORATION OF CASS CAVE, W. VA.: Natl. Speleol. Soc., Bull., v. 21, pt. 1, p. 21-32, 7 illus., map, sec., Jan. 1959.

Cass Cave was first investigated in 1947. In 1949 the systematic exploration of the cave was begun in earnest and carried on until 1957. The entrance to the cave is via a small passage 800 ft. long, 170 ft. of which is a crawlway. Beyond this is a drop of 180 ft. to the floor of the large room which is 830 ft. long, 180 ft. high, and 75 ft. wide. The cave leading from the Big Room is over 5,000 ft. long, consisting of passages of all types from wet crawlways to large rooms and domepits. --Auth.

2-68. O'Brien, Brian J. SPELEOLOGY IN AUSTRALIA: Natl. Speleol. Soc., Bull., v. 21, pt. 1, p. 1-12, 3 illus., 3 maps, Jan. 1959, 16 refs.

The major cavern areas in Australia are the Nullabor Plain of South Australia, the Paleozoic limestone areas of the Eastern States, the Yarrangobilly Plateau of New South Wales, and the Silurian limestone areas of Tasmania. In the Burdekin River area of Queensland, there are some lava tubes. Australian caves have yielded remains of Pleistocene giant marsupials; prehistoric cave paintings are in the caves of the Kimberley area and the Nullabor Plain. Australian speleology is organized primarily in 11 local societies affiliated with the Australian Speleological Federation. --Auth.

2-69. Tedrow, J.C.F., and J.E. Cantlon. CONCEPTS OF SOIL FORMATION AND CLASSIFICATION IN ARCTIC REGIONS: Arctic, v. 11, no. 3, p. 166-179, 8 illus., 3 diags., 1958, pub. 1959, 29 refs.

Designating tundra as a zonal great soil group as are chernozems, laterites, and podzols is seriously questioned. All zonal great soil groups as originally proposed by Dokuchaev develop under free drainage conditions, and was so stipulated by him; such is not the case, however, with tundra soil. A regional climatic soil is present in arctic regions, which is well drained and shows the full impact of regional soil forming factors. It has been named arctic brown soil. Tundra soil must be considered as a hydromorphic, intrazonal soil and represents the northern extension of the glei process.

With the shallow phase arctic brown soil, arctic barrens vegetation is present, while upland meadow vegetative communities colonize the arctic brown sites. The tundra soils usually have wet meadow and shrub types. Bogs are usually colonized by marsh types, but on numerous occasions they may have many species associated with better internal soil drainage. This condition is a result of the various moisture levels present in the bog soils. Before soil and vegetation can be correlated successfully in arctic regions, relative wetness of the site must be integrated with soil morphology.--J. C. F. Tedrow.

2-70. Kaye, Clifford A. SHORELINE FEATURES AND QUATERNARY SHORELINE CHANGES, PUERTO RICO: U.S. Geol. Survey, Prof. Paper 317-B, p. 49-140, 39 illus., 16 maps (1 in pocket, scale 1:240,000), chart (in pocket), 2 secs. (1 in pocket), profile, 7 diags., 2 graphs, 5 tables, 1959, 136 refs.

The coast of Puerto Rico, which is divisible into 5 types of shoreline in 6 separate stretches, is described in detail. Tide, current, sea temperature, salinity, wind, and wave data are given, and the importance of these factors on shoreline development is discussed. The evolution and formation of lunate shorelines is examined and is shown in places to be the result of the molding action of arcuate wave fronts.

The deposition and erosion of $CaCO_3$ in the shore zone is considered in detail. Beachrock occurs along much of the N. coast and in a few places on the S. coast. With 2 exceptions, it coincides with shores fronting extensive limestone terrains. It is suggested that biochemical activity may be largely responsible for beachrock cementation. The distribution, form, origin, and destruction of the cemented dunes of the N. coast are discussed. The flat-floored pits in the spray zone are shown to be due to pool-surface erosion. Tidal terraces, well formed on cemented dune shores, result from pitting and sea-level nip retreat. The origin of the nip is postulated to be due to sea-water solution enhanced in the wave zone by agitation.

Oölite, similar to that making up the Bahamas, is described from NE. Puerto Rico, and its origin is discussed. Lime deposition by blue-green algae produces beach varnish and several types of deposits within the shore zone. Coral reefs occur on all coasts except the N. coast. The reefs are described, and factors affecting growth are discussed.

Pleistocene stratigraphy of the N. coast consists of marine deposits overlain by at least 4 generations of eolianite. Paleosols separate the horizons. All eolianite seems to date from times of low sea level, ranging from Illinoian (?) to post-Mankato. Present sea level is shown to have been established at least 2,000 years ago. Evidence indicates that no sea levels higher than the present have occurred since the deposition of the youngest eolianite. Other data from the island reflecting Pleistocene sea-level changes are discussed.--Auth.

2-71. Sjörs, Hugo. BOGS AND FENS IN THE HUDSON BAY LOWLANDS: Arctic, v. 12, no. 1, p. 2-19, 9 illus.(2 col.), 2 maps, 2 profiles, March 1959, 27 refs.

A fairly nontechnical, brief account is given of certain physiographic and vegetational aspects of the flat chiefly Paleozoic lowlands W. of James Bay. These were submerged into postglacial time and are largely covered by a mantle of calcareous tills and marine clays. Later, extensive peat deposits were developed. The ecological character of the peatland is related above all to access of mineral soil water or its absence, and its variable surface pattern to the type of drainage. The peatland is practically continuous (excepting lakes and riverbeds). Nevertheless "minerotrophic" peatland (fen) is extensive. Large true ("ombrotrophic") bogs also occur, notably on the Attawapiskat River. Special features are bog-pools and, in fen, step-wise arranged, narrow muddy "flarks," and also "black spruce islands" containing permafrost. In the northern parts, permafrost also builds up hillocks of the type known as

"palsas." Otherwise no superficial permafrost is present in the investigated part of the lowlands. The investigation is essentially an application of concepts and methods developed in northern Europe upon the very similar peatlands of boreal and subarctic Canada.--Auth.

2-72. Carter, George F. MAN, TIME AND CHANGE IN THE FAR SOUTHWEST: Assoc. Am. Geographers, Annals, v. 49, no. 3, pt. 2 (supp.), p. 8-30, 9 illus., 4 maps, sec., graph, Sept. 1959, approx. 20 refs.

This article is part of a symposium on "Man, Time and Space" in southern California and is concerned with the American Indian culture over a presumed span of time ranging from early Wisconsin until early historical. The author attempts to reconstruct the changing shoreline of southern California during the numerous changes of the final glacial period of the Pleistocene. The author found evidence to support the belief that this last period of glaciation had in reality 2 separated glacial advances, with a time of considerable thawing in between. This caused much fluctuation in sea level and gave the whole southwestern region of the United States many climatic alterations. These variations gave rise to a complicated set of alluvial fans and bay fills, which were dissected and re-covered a number of times. The anthropological discussion is based on the author's interpretation of the changing ecologic conditions and the shoreline, and to a dating of habitation sites by means of a geologic sequence (very local) pegged on radioactive C counts. --C. W. Schrieber.

3. STRUCTURAL GEOLOGY

See also: Stratigraphy 2-95, 2-98; Geophysics 2-156, 2-158, 2-159; Fuels 2-240.

2-73. Drewes, Harald D. TURTLEBACK FAULTS OF DEATH VALLEY, CALIFORNIA: A REINTERPRETATION: Geol. Soc. America, Bull., v. 70, no. 12, pt. 1, p. 1497-1508, 4 illus., 3 maps, secs., Dec. 1959, 7 refs.

Turtlebacks are smooth, curved surfaces, which form N.-northwestward-plunging elongate domes on the E. side of Death Valley. These surfaces are roughly parallel to bedding or foliation of anticlines in Precambrian schist, gneiss, and marble. Late Cenozoic fan and playa deposits are faulted over these surfaces along the turtleback faults.

Previously the turtleback faults have been interpreted as part of a thrust fault, perhaps the Amargosa thrust fault, that was arched after thrusting. They are interpreted here as individual normal faults younger than the thrust fault and, contrary to previous interpretations, much younger than the formation of the anticlines in the Precambrian rocks.

The tectonic history of this unusual area is here considered to include the following events: 1) Precambrian folding of the Precambrian rocks: 2) post-Paleozoic and pre-middle(?) Tertiary Amargosa thrusting; 3) uplift and erosion of Paleozoic strata and the Amargosa thrust fault, down to the folded Precambrian rocks in the Black Mountains block; 4) middle(?) Tertiary rhyolite extrusions and the accumulation of later Tertiary fan and playa deposits; 5) Pliocene or Pleistocene uplift of the Black Mountains relative to Death Valley, along the Black Mountains fault system, with consequent removal of support for the Tertiary deposits on the turtleback surfaces, and the development of the turtleback faults by normal faulting, or sliding, of the Tertiary sedimentary rocks down the turtleback surfaces toward Death Valley; and, 6) Pleistocene to Recent renewal of movement on the Black Mountains fault system.--Auth.

2-74. Melhorn, Wilton N., and Ned M. Smith. THE MT. CARMEL FAULT AND RELATED STRUCTURAL FEATURES IN SOUTH-CENTRAL INDIANA: Indiana, Geol. Survey, Rept. Prog. 16, 29 p., pl., 2 tables, 1959.

The Mt. Carmel fault extends 50 mi. NNW. across Washington, Jackson, Lawrence, and Monroe counties. It is a normal dipslip fault that dips about 69°W. and exhibits vertical displacement of 80 to 175 ft. The fault zone is marked by steep dips, drag folding, and glide planes in Osage and Meramec shale and limestone. Evidence was not seen of graben structures or cross faulting as suggested by previous writers, although numerous subsidiary fractures are found as far as 1 1/2 mi. from both sides of the fault.

Movement along the fault may have begun in late Meramec or early Chester time and probably was concluded by early Pennsylvanian time. Deposition of Chester and early Pennsylvanian(?) clastic sediments was influenced by regional structural irregularities resulting from the faulting. A genetic and chronologic relationship between the Mt. Carmel fault and the LaSalle anticline and similar structures of the Illinois basin is suggested.

Adjacent to the fault on the downthrown side is the Leesville anticline. On the crest of this anticline are 5 structural domes. Although only minor amounts of oil and gas have been produced from Devonian and Ordovician limestones in these domes, one of the domes has not been drilled, and only one of the others has been drilled deeper than the upper part of the Knox dolomite. The possibility of petroleum entrapment against the fault remains to be tested.--Auth.

2-75. Chenoweth, Philip A. AN OUTLIER ON THE MUENSTER-WAURIKA ARCH: Oklahoma Geology Notes, v. 19, no. 9, p. 192-194, map, Sept. 1959.

The Muenster-Waurika arch is an early Pennsylvanian mountain range now buried beneath late Pennsylvanian and Permian sediments. Deep drilling on the arch in Jefferson County, Oklahoma, has revealed the presence of a small outlier of Viola and Simpson limestones (Ordovician) in a graben near the crest of the arch surrounded by Arbuckle dolomite (Cambrian). Nearest known occurrence of the Viola limestone is approximately 16 mi. NE. in the trough of the Marietta syncline. The outlier testifies to the complexity of folding and faulting along the arch.--Auth.

2-76. Chenoweth, Philip A. RECUMBENT FOLDING IN THE VELMA AREA: Oklahoma Geology Notes, v. 19, no. 10, p. 219-220, log, Oct. 1959, 2 refs.

The Skelly Oil Company's No. 1 Leonard, a deep vell in the E. part of the Velma oil pool in Stephens County, Oklahoma, encountered the County Line imestone (Pennsylvanian) at 4 different levels. Electric log interpretation has led to the conclusion hat this well passed through a recumbent fold and reverse fault. This is indicative of the intensity f folding and faulting in the Velma area, a classic xample of complex faulting and folding.--Auth.

-77. Kozyrev, N.A. VOLCANIC ACTIVITY ON THE MOON. Translated by Edgar Huston: Internat. Geology Rev., v. 1, no. 10, p. 40-44, 2 illus., Oct. 959.

On Nov. 3, 1958, the author observed ejection of olcanic ash and gases from the central peak of Alphonsus crater. Spectrographic analysis of gas luorescence induced by hard solar radiation, proved hat gases were escaping from the crater floor. It ppears that tectonic activity is taking place on the noon. Lack of atmosphere and consequent porosity caused by rapidly escaping gas) of surface layers ave resulted in reduced heat emission, these factors ll contributing to the moon's ability to retain internal nergy sufficient to initiate tectonic activity. Fissures and dark spots on crater floors indicate endogenic development of the moon's basic surface relief, s opposed to relief development by meteoric impact. -D. D. Fisher.

-78. Menard, Henry W. MINOR LINEATIONS N THE PACIFIC BASIN: Geol. Soc. America, Bull., 70, no. 11, p. 1491-1495, 2 maps, diag., Nov. 959, 14 refs.

Minor lineations 20-200 km. long consist of: 1) longate submarine volcanoes, atolls on volcanic latforms, and volcanic islands; 2) lines of closely paced circular submarine volcanoes; 3) asymmetical ridges; 4) narrow troughs associated with arallel asymmetrical ridges; 5) straight troughs esembling submarine canyons on continental and nsular slopes. Two patterns of minor lineations re identified, a pinnate pattern centered on major ineations such as fracture zones, archipelagoes, nd island arcs, and a herringbone pattern within the major crustal blocks. The pinnate pattern resembles feather with major lineations as the shaft and minor ineations as the barbs. The angle formed by the "V" f the barbs ranges from 66°-140°, and it is commony not bisected by the major lineation. The angles ormed by minor lineations on opposite sides of major lineations were found to be from 70°-90° for racture zones, 105°-110° for archipelagoes, and 40° for the Kurile trench. Although grouping into lasses is suggestive, the sample is not large enough o insure that significant differences in angles exist mong the types of major lineations. Even though an xception to the trend of minor lineations is found S. f the Murray fault zone, the normal trend is as niform as any continental fault pattern distributed ver an equivalent area. Pinnate lineations are ssociated with the Murray fracture zone and Pioneer idge that have horizontal displacements of 150 km. nd 250 km. respectively. A similar pattern is ssociated with many other major lineations in the acific basin. If it can be demonstrated that the major and minor lineations are genetically related, would suggest that horizontal movement has taken lace on all major lineations in the Pacific basin. he herringbone pattern arises from the fact that e barbs of the pinnate pattern of adjacent fracture zones point in opposite directions. Some lineations in the middle of crustal blocks suggest that the herringbone pattern is more significant although not so definite as the pinnate one. Not enough is known about the herringbone pattern to make elaborate speculations about their origin.--B. W. Pipkin.

2-79. Charlesworth, H.A.K. SOME SUGGESTIONS ON THE STRUCTURAL DEVELOPMENT OF THE ROCKY MOUNTAINS OF CANADA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 11, p. 249-256, 2 maps, sec., 2 diags., Nov. 1959, 19 refs.

Three distinct types of deformation: thrusting and folding, wrench-faulting, and normal faulting, were involved in the building of the Rocky Mountains of Canada. Thrusting and folding throughout the Canadian Rockies, together with wrench-faulting in the western ranges, may have resulted from a southwesterly movement of the underlying Precambrian basement with respect to rocks of the western Cordillera. A period of minor normal faulting may have been related to later epeirogenic uplift.--Auth.

2-80. Grose, L. Trowbridge. STRUCTURE AND PETROLOGY OF THE NORTHEAST PART OF THE SODA MOUNTAINS, SAN BERNARDINO COUNTY, CALIFORNIA: Geol. Soc. America, Bull., v. 70, no. 12, pt. 1, p. 1509-1547, 21 illus., 4 maps (1 fold. col., scale 1:31,680), 9 secs. (8 on fold. sheet), diag., Dec. 1959, 63 refs.

The geology of about 200 sq. mi. in the NE. part of the Soda Mountains just W. of Baker in the Mojave Desert of California was mapped on air photographs of scale 1:13,000.

An important N. 25°W. right-lateral fault, herein named the Soda-Avawatz fault, divides the region into 2 distinctly different geologic areas. In the eastern area the following rocks occur: 1) metasedimentary rocks of probable Precambrian age, 2) the Prospect Mountain quartzite which is thought to be Lower Cambrian, 3) dolomite of middle Paleozoic(?) age, and 4) a complex of plutonic rocks ranging from diorite to granite. The western area consists of: 1) Mississippian-Pennsylvanian(?) limestone and hornfels, 2) lower Permian limestone of the Bird Spring formation, 3) Lower Triassic limestone and shale, 4) Triassic-Jurassic andesite and quartzite herein named the Soda Mountain formation, and 5) upper Mesozoic intrusive rocks different from those in the eastern area.

In the eastern area, Lower Cambrian(?) quartzite of restricted extent constitutes an isolated thrust complex, and intensely deformed middle Paleozoic(?) dolomite occurs in klippen which are intruded by plutonic rocks. In the western area, highly disordered allochthonous upper Paleozoic limestones occur in fragmentary blocks. These are irregularly downfaulted into an equally disordered para-autochthon of Mesozoic volcanic rocks. The thrust complex was passively intruded by upper Mesozoic quartz diorite, quartz monzonite, and granite. The intrusions effected unusually large zones of contact metamorphism (garnetization) and regional hydrothermal alteration (albitization and epidotization).

Several thousand feet of the lower Pliocene Avawatz formation consisting of fanglomerate, sandstone, and monolithologic limestone breccia occurs in the district and is prevalent along the Soda-Avawatz fault zone. The limestone breccia originated by landsliding and normal fanglomerate accumulation coeval with oblique-slip movement of

the Soda-Avawatz fault.

Deformation took place during the middle and late Mesozoic and is considered part of the Nevadan-Laramide orogeny. This resulted in isoclinal folding, thrusting, and block faulting. The upper plates of the thrusts may have moved westward with respect to the lower blocks, but the evidence is inconclusive. Granitic intrusion followed deformation and was locally guided by preestablished vertical and low-angle faults.

The Soda-Avawatz fault zone is the most prominent structure in the Soda Mountains. Ranging in width from 1 to 2 mi., it consists of 3 principal through-going faults and numerous branching faults characterized by wide zones of granulation and rock slivering, near-horizontal slickensides, and apparent reversal of throw along the strike. A large anticline is squeezed up within the fault zone. Most of the movement occurred during late Cenozoic, but features indicating recent displacement are lacking. The strongest evidence for right-lateral displacement is the echelon arrangement of folds and secondary faults. Since specific geologic features in the Soda Mountains cannot be matched across the fault, the amount of displacement is unknown.

The Soda-Avawatz fault continues northward along the E. side of the Avawatz Mountains and becomes the Death Valley fault zone. Together they form a regionally significant NW.-trending right-lateral fault zone. More recent movement on the E.-W. Garlock fault has forced an eastward bulge in the Death Valley - Soda-Avawatz fault where the faults join on the NE. side of the Avawatz Mountains.

During most of the late Paleozoic and Mesozoic eras, the Soda Mountains area lay in a transition zone between miogeosynclinal environment to the E. and eugeosynclinal environment to the W. The Death Valley - Soda-Avawatz fault seems to coincide in part with this transition zone and was perhaps localized by it. --Auth.

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 2-35, 2-45; Geomorphology 2-58; Geochemistry 2-183; Fuels 2-240 through 2-244.

2-81. Wilson, Druid, Grace C. Keroher, and Blanche E. Hansen. INDEX TO THE GEOLOGIC NAMES OF NORTH AMERICA: U.S. Geol. Survey, Bull, 1056-B, p. 407-622, 1959, 52 refs.

In this report the geologic names of North America, including Greenland, the West Indies, the Pacific Island possessions of the United States, and the Trust Territory of the Pacific Islands, that were published before 1956 are arranged to form a non-alphabetic index to M. Grace Wilmarth's Lexicon of Geologic Names of the United States (including Alaska) and to the Geologic Names of North America Introduced in 1936-1955 by Druid Wilson and others. Some names entered in Wilmarth's lexicon have been omitted. These include: 1) all paleontologic and descriptive terms, 2) all names of economic units, such as miner's terms, trade names, and subsurface names identical with the names of formal rock units, 3) names of moraines and other units of which physiography is an essential part of the definition, and 4) names of orogenies. Names of units adopted by the U. S. Geological Survey through 1958 appear in boldface type under their currently designated ages. Names are grouped under 2 main categories: 1) geologic-time and time-stratigraphic units, and 2) rock units. The geologic-time and time-stratigraphic units are grouped together under the major time divisions. The names of the rock units are listed only once - in the geographic area that contains the type area or locality. --From introd.

2-82. Bell, W. Charles, Grover E. Murray, and L. L. Sloss, co-chairmen. SYMPOSIUM ON CONCEPTS OF STRATIGRAPHIC CLASSIFICATION AND CORRELATION: Am. Jour. Sci., v. 257, no. 10, p. 673-778, illus., maps, charts, secs., diags., tables, Dec. 1959, refs.

This symposium originated during the annual meeting of the Research Committee, Society of Economic Paleontologists and Mineralogists, St. Louis, Missouri, 1957. The papers published in this issue of the American Journal of Science are limited versions of those originally presented to the A. A. P. G.-S. E. P. M. 1959 annual meeting. The symposium was designed to review the concepts and principles involved, and to touch on the various approaches to classification and correlation, including nomenclature. The selection of speakers and their topics was planned to achieve a balance between 1) classic and new approaches to the problem, 2) strata of various ages, and 3) geographic areas (geologic provinces). It is hoped that the results of the symposium will prove of value to geologists in general and also to commissioners of the American Commission on Stratigraphic Nomenclature in their current attempts to solidify the language of a new Stratigraphic Code. --From introd.

The papers are abstracted below in the order in which they appear in the symposium.

2-83. Hedberg, Hollis D. TOWARDS HARMONY IN STRATIGRAPHIC CLASSIFICATION (In: Bell, W. Charles, and others. Symposium on Concepts of Stratigraphic Classification and Correlation: Am. Jour. Sci., v. 257, no. 10, p. 674-683, table, Dec. 1959).

Stratigraphic classification is the systematic zonation of the strata of the earth's crust with reference to any of the many different properties or attributes which rock strata may possess. It is an essential step for us, both toward the scientific and philosophic understanding of the rocks of the earth's crust and toward their economic utilization.

This concept of stratigraphic classification is extremely simple, and offhand it is hard to see why there should be any problems other than the strictly geological ones involved in the accurate scientific identification of stratigraphic characters and the selection, tracing, and definition of units based on variations in these characters. That there are other problems, and even some degree of confusion and controversy, seems to result principally from the following:

1) Lack of a clear concept of what is being classified.

2) Lack of adequate standards of reference for specific stratigraphic units.

3) Attempts to zone strata according to 2 or more different characters using only one set of units.

4) Lack of precise and uniform terminology.

5) Proliferation of unnecessary terms.

6) Influence of preconceived notions on strati-raphic classification handed down from the early tages of the development of stratigraphy.

7) Intolerance by specialists in one field of strati-raphic classification toward potential contributions f other fields.

Great progress is being made toward general greement on principles of stratigraphic classifi-ation and toward uniformity of usage in terminol-gy. The work of the International Subcommission n Stratigraphic Terminology, as well as that of the everal national commissions on stratigraphic omenclature is showing excellent results. Recent uestionnaires distributed to stratigraphers through-ut the world, as well as other samplings of thought nd opinion, reveal a very encouraging trend toward armony on points of stratigraphic classification and erminology which only a short time ago were con-used by very diverse viewpoints. A summary of he conclusions arising from 75 replies to a recent orld-wide questionnaire of the International Sub-commission on Stratigraphic Terminology is par-icularly illuminating. Some areas of controversy till remain, but the goal of reasonably close inter-ational accord appears definitely attainable. An nteresting variation in views on stratigraphic clas-ification lies in the concept of the U. S. S. R. Strati-raphic Commission of a single kind of stratigraphic lassification resulting in a single set of units based n natural stages in the development of the earth's rust, in contrast to the multiple kinds of stratigraph-c units to which most of the rest of the world appears o subscribe.--Auth.

-84. Rodgers, John. THE MEANING OF COR-RELATION (In: Bell, W. Charles, and others. Sym-osium on Concepts of Stratigraphic Classification nd Correlation: Am. Jour. Sci., v. 257, no. 10, . 684-691, sec., Dec. 1959) 12 refs.

The word correlation ordinarily means simply mutual interdependence or interrelation, but when it vas introduced into stratigraphy in the later 19th entury, it was used to mean the process of deter-mining the time relations of strata. More recently, broader meaning has been advocated - determining quivalency or continuity in lithology or fauna as vell as time relations. These different equivalen-ies do not necessarily agree because of facies elationships like transgression, but the criteria used to establish them overlap broadly, and ultimate-y the acceptability of such criteria depends on their alidity in establishing the true time relations. Hence, in stratigraphy, the older narrower definition f correlation should be retained.--Auth.

-85. Wheeler, Harry E. STRATIGRAPHIC UNITS N SPACE AND TIME (In: Bell, W. Charles, and thers. Symposium on Concepts of Stratigraphic lassification and Correlation: Am. Jour. Sci., v. 57, no. 10, p. 692-706, chart, Dec. 1959) 31 refs.

The physical basis for stratigraphy should be estricted to surface-accumulated (sedimentary and olcanic) rocks; intrusive igneous, metamorphic, nd other post-depositionally emplaced bodies should e excluded.

Relationships involve at least a four-dimensional pace-time continuum which, for ease of concept and onvenience of graphic portrayal, may be subdivided nto 2 three-dimensional frameworks: 1) a spatial ramework in which all intrinsically objective (physical and biostratigraphic) units are defined; and 2) a framework with lateral spatial dimensions and a vertical temporal dimension, in which all subjective (time-stratigraphic) units are defined.

Transposition (with appropriate distortion) of the objective, spatial elements to the subjective, space-time framework (or vice versa) provides bases for integration and potentially complete historical inter-pretation. Moreover, such an integrated system, insofar as it may be dimensionally valid and other-wise logically constructed, tends to induce consider-ation of various essential relationships which com-monly have been disregarded in stratigraphic analyses and historical interpretations.

Present geologic knowledge and practices imply that 4 basic principles and numerous distinctional factors or criteria must be satisfied. The principles are superposition, faunal succession, base-level, and datum variance. Among the distinctional criteria are subjectivity and objectivity; physical, bio-, and time-stratigraphic; environmental ("ecostratigraph-ic") and nonenvironmental control; natural and arbi-trary configuration; mode of contiguity (vertical, lateral, and intertongued); mappability and scale; lithology; unconformity; evolution; "uniformity" and heterogen-eity; barrenness; lateral variation (facies); deposi-tion, nondeposition, and erosion (stratigraphic cycle); tangibility; and continuity versus discontinuity.

Although the number of factors appears unwieldly, if the physical, bio- and time-stratigraphic categories are shown on one coordinate axis, and if the other factors, as additional bases for unit configuration, are appropriately applied to the other, a reasonably simple, dual (space and space-time) classification may be constructed.--Auth.

2-86. Storey, Taras P., and J.R. Patterson. STRATIGRAPHY - TRADITIONAL AND MODERN CONCEPTS (In: Bell, W. Charles, and others. Sym-posium on Concepts of Stratigraphic Classification and Correlation: Am. Jour. Sci., v. 257, no. 10, p. 707-721, 6 figs. incl. illus., chart, diags., Dec. 1959) 28 refs.

Traditional stratigraphic units consist of one or more contemporaneous lithologic and faunal facies within a specific layer of rock. Each layer is local and regional in extent and is separated from other layers by real time-significant boundaries which are either planes of contemporaneity or planes of unconformity. Where the boundaries are indistinct, faunas characteristic of the specific layer, and the stratigraphic succession in general, are used to identify the stratigraphic unit. Because of its region-al attributes the stratigraphic unit serves as a cor-relation unit, as well as being the basic unit for local and regional stratigraphic subdivision and terminol-ogy. Zone, stage, series, and system are such units which informally may be termed stratigraphic formations having regional time-significance.

Accusation by supporters of the American Stratigraphic Commission that geologists fail "to exclude concepts of time from consideration of the objective data on which alone properly defined rock units are differentiated," is not applicable to concepts of traditional stratigraphy. This accusation applies only to modern concepts of litho-, bio-, and chrono-stratigraphy, which, while erroneously considered to be stratigraphic, more correctly are regarded as prestratigraphic procedures and concepts. Modern stratigraphic terms do not correspond with tradi-tional concepts because litho- and biostratigraphy do not discriminate between distinct stratal super-

position and different transgressive lithologic facies, or between stratigraphic paleontology and facies fossils. This failure has led to misconceptions in chronostratigraphy and to development of unrealistic and inadequate terms, as well as to misapplication of traditional terms. Consequently, modern concepts and terms are arbitrary and of questionable utility except in prestratigraphic procedures.--Auth.

2-87. Cumming, A.D., J.G.C.M. Fuller, and J.W. Porter. **SEPARATION OF STRATA: PALEOZOIC LIMESTONES OF THE WILLISTON BASIN** (In: Bell, W. Charles, and others. Symposium on Concepts of Stratigraphic Classification and Correlation: Am. Jour. Sci., v. 257, no. 10, p. 722-733, 6 figs. incl. map, profiles, diags., Dec. 1959) 19 refs.

The recognition of thin, persistent marker beds in the Mississippian rocks of the Williston Basin led to a logical separation of these rocks and illustrated the inadequacies of previous subdivisions. Present in number in the dominantly carbonate lower Paleozoic succession in the basin, similar marker beds have been used to yield an understanding of the stratigraphy of these older rocks.

Here termed "nonsequential beds," the marker beds are clastic interruptions in a carbonate and sulfate succession which commonly exhibits rhythmic variations. They would appear to be the tangible expressions of diastrophic pulses which terminated periods of widespread standstill in sedimentation. The nonsequences marked by the nonsequential beds in the Paleozoic column of the Williston Basin delineate a number of para-time rock units which the writers choose to refer to as "beds."

Irrespective of terminology, the method of separation of strata should prove applicable and rewarding in cratonic basins where carbonate-evaporite deposition far exceeds sand-clay deposition.--Auth.

2-88. McLaren, D. J. **THE ROLE OF FOSSILS IN DEFINING ROCK UNITS WITH EXAMPLES FROM THE DEVONIAN OF WESTERN AND ARCTIC CANADA** (In: Bell, W. Charles, and others. Symposium on Concepts of Stratigraphic Classification and Correlation: Am. Jour. Sci., v. 257, no. 10, p. 734-751, 4 maps, 4 secs., Dec. 1959) 25 refs.

The formation is rightly considered the fundamental unit of rock classification. Definition must be broadly based if flexibility is to be maintained. Fossils as lithologic constituents are equal to any other physical constituent in defining rock units. Their use in this role must not be confused with their interpretive use in biostratigraphic correlation, for which biostratigraphic units are employed. These units are indistinguishable from time-stratigraphic units if the latter are redefined as practical working units; the hierarchy system, series, stage will serve for both.

Three examples are given of the use of fossils in largely reconnaissance mapping of richly fossiliferous Devonian rocks: 1) On Ellesmere and Bathurst islands the correlation of roughly similar lithologic successions is supported by a sequence of faunas that allows recognition of the same 4 formations on the 2 islands, 200 mi. apart. 2) Near Kakisa River, upper Mackenzie Valley, where owing to poor outcrop, the upper boundary of a formation, that may be seen to correspond with a lithologic break only where the rocks are better exposed, is most conveniently defined by a marked faunal break. Structure was mapped by collecting fossils from small isolated outcrops in the area. 3) In the Alberta Rocky Mountains, difficulties experienced in choosing a consistent boundary between the Upper Devonian Fairholme group and the overlying Alexo formation may be solved in fossiliferous sections by using a marked faunal break that commonly corresponds to one of several possible boundaries, if lithology is considered exclusively.

In these examples, the meaning of faunal changes or breaks is not relevant to formation definition. Thus no interpretation is involved, and the fossils are as much a physical character of the rocks as any other character.--Auth.

2-89. Young, Keith. **TECHNIQUES OF MOLLUSC ZONATION IN TEXAS CRETACEOUS** (In: Bell, W. Charles, and others. Symposium on Concepts of Stratigraphic Classification and Correlation: Am. Jour. Sci., v. 257, no. 10, p. 752-769, 8 figs. incl. map, secs., Dec. 1959) 37 refs.

The objective of the investigation, the kinds and numbers of fossils available, and the scale of the investigation all influence the type of zonation that will be used in any particular sequence of rocks. In an Edwards limestone study, the purpose being paleoecologic, the zones are based on sessile molluscs and are biosomal, but a single lithosome may be coextensive with more than one zone. No zones are coextensive with more than one lithosome; zonation is a technique with which to obtain data for further interpretation.

A study in the Georgetown limestone consists of a detailed correlation of appearances and disappearances of mutually overlapping ammonite teilzones. In this study the zones are those parts of teilzones that are or are not overlapped, arbitrarily depending on whether an appearance or a disappearance is more useful for the investigation.

Strata which can be correlated with the Austin chalk at Austin change rapidly from shale to chalk to limestone to black shale to flaggy limestone. The shale and limestone lithosomes contain ammonite sequences which are usually mutually exclusive. Within a single lithosome assemblage zones are useful and practical, but correlations from one lithosome to another is made only by the rare occurrences of single ammonites which seem to have been buried outside of their optimum environment. These single occurrences are neither index fossils nor guide fossils in the most recent interpretations.

None of the 4 techniques used above produce units that can be called zones in a chronostratigraphic sense. All of them are zones in the wider interpretation of that word, and the Edwards limestone zones also approach the meaning of the term zone as used by some ecologists.--Auth.

2-90. Wilson, John Andrew. **STRATIGRAPHIC CONCEPTS IN VERTEBRATE PALEONTOLOGY** (In: Bell, W. Charles, and others. Symposium on Concepts of Stratigraphic Classification and Correlation: Am. Jour. Sci., v. 257, no. 10, p. 770-778, 4 diags., Dec. 1959) 4 refs.

Vertebrate paleontologists use "local fauna" for the totality of taxa found at one or a few neighboring localities and prefix a geographic name, i. e., Garvin Gulley local fauna. If the fauna can be traced more or less continuously within a sedimentary province, the word "local" is dropped, i. e., Garvin Gulley fauna. This would be equivalent to the biostratigraphic term range zone.

Type sections in stratigraphic classification should have no more significance than name bearers. They are one-dimensional samples of three-dimensional bodies of rock.--Auth.

2-91. Glover, Lynn. **STRATIGRAPHY AND URANIUM CONTENT OF THE CHATTANOOGA SHALE IN NORTHEASTERN ALABAMA, NORTHWESTERN GEORGIA AND EASTERN TENNESSEE: U.S. Geol. Survey, Bull. 1087-E, p. 133-168, illus., 5 maps (2 in pocket), 3 secs. (in pocket), graph, 2 tables, 1959, 16 refs.**

In northeastern Alabama, northwestern Georgia, and eastern Tennessee, the Chattanooga shale of Late Devonian age ranges in thickness from 0 to more than 40 ft. Most of the shale is of the Gassaway member, though the Dowelltown member is present in part of eastern Tennessee. Beds of Dowelltown age were found in a small area in Alabama and Georgia, but the member is not recognized there. The Chattanooga shale and the overlying Maury formation, which is chiefly of Mississippian age, are progressively overlapped in the vicinity of Birmingham, Alabama.

Along the eastern margin of the late Chattanooga sea, which coincided roughly with the region studied, stable shelf conditions prevailed, but the degree of stability was somewhat less than that to the W. in the eastern highland rim area. This difference is indicated in the E. by the somewhat more silty and sandy sections, intraformational conglomerates, greater range in thickness of the shale, and in a few places by preservation of basal conglomerate. Phosphate nodules and minor amounts of chert were deposited in the E., and the distribution of each is areally and stratigraphically distinct. The chert probably accumulated in quieter water than did the phosphate.

Occasional influxes of greater than usual amounts of inorganic material produced the gray beds common in the Chattanooga. These beds have more clay and less organic matter than do the black beds.

The Maury formation in Georgia and southeastern Tennessee contains lentils of black shale; in central eastern Tennessee where the typical greenish Maury lithology is absent, beds equivalent in age to the Maury are of black and gray shale.

Less stable conditions of deposition and wide distribution of phosphatic black shale account for the generally low U content (less than 0.005%) of the Chattanooga shale in the region studied.--Auth.

2-92. SYMPOSIUM ON THE MISSISSIPPIAN OF OKLAHOMA AND KANSAS: Tulsa Geol. Soc. Digest, v. 27, p. 84-205, maps, secs., charts, 1959, refs.

This, the first of the Digest's annual symposia on subjects of general geological interest, is a collection of 10 original papers, all of which were presented at the Mississippian Symposium held in Norman, Oklahoma, Feb. 24-25, 1959, sponsored by the School of Geology and the Extension Division of the University of Oklahoma. Several of the papers were partially revised for this publication.--From foreword by A. Goldstein, Jr.

The papers are abstracted separately below in the order in which they appear in the Symposium.

2-93. Branson, Carl C. **MISSISSIPPIAN BOUNDARIES AND SUBDIVISIONS IN MID-CONTINENT (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 85-89, 1959)**

Classification and correlation of Mississippian units has been confused because similar lithofacies and biofacies have been considered equivalent. Time-rock units have been thought missing whereas they are present in different facies. It is suggested that the base of the Kinderhookian series be restored to its original position and that the redefined Kinderhookian and the Osagean be combined into a single series, one for which no name has yet been proposed. --Auth.

2-94. Curtis, Doris M., and Stephen C. Champlin. **DEPOSITIONAL ENVIRONMENTS OF MISSISSIPPIAN LIMESTONES OF OKLAHOMA (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 90-103, 4 maps, secs., 2 charts, 1959) 20 refs.**

Interpretation of depositional environments of Mississippian limestones of Oklahoma indicates that the waters of Mississippian seas were shallow and warm. Waters of early Mississippian seas were quiet and protected, among scattered islands almost at sea level. More widespread later Mississippian seas had greater stretches of open, less quiet water. Subsidence and basin filling in the Anadarko basin area increased toward late Mississippian time. Lands to the S. supplied an increasing amount of detrital sediment toward late Mississippian time.

The reconstruction of the depositional environments during Mississippian time in Oklahoma was made on the basis of regional study of distribution, thickness, and gross lithographic characteristics of Mississippian limestones, as compiled from published and unpublished sources.--Auth.

2-95. Huffman, George G. **MISSISSIPPIAN STRATIGRAPHY AND TECTONICS OF THE OKLAHOMA OZARK AREA (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 104-112, 2 maps, 3 secs., 1959) 4 refs.**

Rocks exposed in the Oklahoma Ozark area range in age from Precambrian to Middle Pennsylvanian. Early Paleozoic units are beveled by unconformity and are overlapped northward by the Chattanooga black shale (Late Devonian and Early Mississippian).

Post-Chattanooga beds include the St. Joe group (Compton, Northview, and Pierson) of Kinderhookian and early Osagean age, Reeds Spring and Keokuk formations (Osagean), Moorefield formation (Meramecian), Hindsville, Fayetteville, and Pitkin formations (Chesterian). Osagean units disappear southward by truncation and are overlapped northward by the Moorefield. The latter is beveled northward by unconformity and overlapped by the Hindsville which lies on Osagean cherts in northern exposures. Overlying Fayetteville and Pitkin are truncated northward by pre-Pennsylvanian erosion and are succeeded by Hale, Bloyd, and Atoka formations (Pennsylvanian).

Northeastern Oklahoma lies on the southwestern end of the Ozark dome. Formations strike in an arcuate pattern and dip gently away from the uplift. Regional dip is interrupted by NE.-trending faults and minor folds which roughly parallel the Ozark axis.

Structural development in northeastern Oklahoma is closely associated with that of the Ozark geanticline which underwent successive emergences, sub-

mergences, and tiltings during the Paleozoic. Major deformation occurred in Middle Pennsylvanian (Des Moinesian) time. Folds and faults are post-Boggy and pre-Tiawah (Senora) in age. Parallelism of structures with those in the Arkansas Valley syncline suggest genetic relations. Deformation is largely tensional in nature, resulting from stretching of rock layers across the end of the positive Ozark area following orogenic movement in the Ouachitas and subsequent adjustment in the McAlester basin area. --Auth.

2-96. Chenoweth, Philip A., Jordan C. Braun, Stephen C. Champlin, and Jefferson D. Prestridge. **SYCAMORE AND RELATED FORMATIONS OF SOUTHERN OKLAHOMA** (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 113-123, 3 maps, chart, 3 secs., 1959) 28 refs.

The Sycamore formation [Mississippian] of the southern Arbuckle Mountains and the Ardmore basin is divisible into 3 distinct stratigraphic units, in ascending order the Welden formation, the pre-Sycamore formation, and the Sycamore limestone. The Welden formation, generally less than 10 ft. thick, is identical to the Welden limestone and the pre-Welden shale of the Lawrence uplift; it is Kinderhookian in age, resting disconformably on the Woodford (Devonian) shale. The pre-Sycamore comprises up to 300 ft. of glauconitic cherty limestone and fucoidal shale. It is probably Osagean. The Sycamore limestone reaches a maximum thickness of 300 ft. in the center of the Ardmore basin. It is a dense, tough silty to sandy limestone grading vertically and laterally into the silty calcareous shale of the Ahloso member of the Caney shale. It is Meramecian in age.

The Welden formation is best developed in the area of the Arbuckle Mountains and the Ardmore basin. In the Lawrence uplift and in the Seminole area the unit extends beyond the limit of the pre-Sycamore. The pre-Sycamore is restricted to the Arbuckle Mountains and the area to the S. and W. Post-Osagean erosion has stripped off all of the pre-Sycamore and most of the Welden from the region to the N. and E. The Sycamore limestone overlaps the truncated edges of the Welden and pre-Sycamore so that in the southeastern Anadarko basin the Sycamore rests disconformably on the Woodford. Elsewhere, the Sycamore limestone has changed facies to the Ahloso shales which lie on Welden or on Woodford. --Auth.

2-97. Jordan, Louise, and T. L. Rowland. **MISSISSIPPIAN ROCKS IN NORTHERN OKLAHOMA** (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 124-136, 4 maps, 2 secs., log, 1959) 16 refs.

Mississippian rocks divided into series by lithologic criteria and by electric log character underlie Early or Middle Pennsylvanian rocks in the central part of northern Oklahoma. Osagean rocks or, locally, rocks older than Mississippian underlie Middle Pennsylvanian strata along the N.-trending central Oklahoma arch which includes the Nemaha ridge to the W., the Oklahoma City uplift at the S., and the Cushing anticline to the E. The arch narrows southward as a result of greater uplift and steeper dip, so that on its W. flank, the boundaries of Chesterian and Meramecian units, which are beveled by Early and Middle Pennsylvanian erosion, trend E. and then S. toward the Oklahoma City uplift. From the E. the boundaries trend SW. and then S. on the E. side of the uplift.

Chesterian strata thicken toward the Anadarko and McAlester basins. Meramecian rocks rest with angular unconformity upon the Osagean unit, and both series thicken northward on the E. side of the arch. --Auth.

2-98. Merriam, Daniel F., and Edwin D. Goebel. **STRUCTURE OF MISSISSIPPIAN ROCKS IN SOUTHEASTERN KANSAS** (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 137-158, 13 maps, sec., 1959) 32 refs.

Mississippian rocks in southeastern Kansas have long been economically important because of the petroleum reserves contained in them. Rocks of Kinderhookian, Osagean, Meramecian, and Chesterian age are represented chiefly by a carbonate sequence collectively termed "Mississippi lime." The Chattanooga shale is considered with the Mississippian because of the important unconformity at the base of the unit. Thickness of the Chattanooga ranges from a featheredge to slightly more than 200 ft; thickness of "Mississippi lime" ranges from a featheredge to 450 ft.

Regional dip on the surface of Mississippian rocks in southeastern Kansas is W. or slightly N. of W. This homoclinal surface is interrupted by numerous minor but economically important oil-bearing structures including the Fredonia dome, Longton ridge, Beaumont anticline, and Winfield anticline. The Nemaha anticline is the dominant structural feature of southeastern Kansas; other structural trends are subordinate but nearly parallel to it. In general, structure increases with depth, crests of structures shift with depth, and the SE. flank of most NE.-trending structures is steeper than the NW.

About 136 fields now produce from Mississippian rocks in southeastern Kansas. Box, Countryman, Posey, Weathered, and Webb fields produce on closed anticlinal structures, and Albright seemingly produces from a stratigraphic trap.--Auth.

2-99. Clinton, Rick P. **HISTORY OF PETROLEUM DEVELOPMENT OF MISSISSIPPIAN OIL AND GAS** (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 159-165, 1959).

A short history of the development programs in which the Mississippian was the primary objective is given, with a few facts about how these reserves were found in this portion of the geological column. Also mentioned are a few areas that the author considers prospective.--From auth. abs.

2-100. Wilson, L. R. **THE USE OF FOSSIL SPORES IN THE RESOLUTION OF MISSISSIPPIAN STRATIGRAPHIC PROBLEMS** (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 166-171, illus., chart, 1959) 9 refs.

Fossil spores and pollen have become useful indicators of geological age, paleoecology, and paleogeography because they are abundant minute bodies that preserve in many types of sediment and because they are characteristic of the various geologic ages and ecologies. Their importance in the resolution of Mississippian stratigraphic problems

is evident from the studies that have been published in the United States and Eurasia. Certain genera of fossil spores are restricted to these rocks. The spore genera whose species appear to be the most useful in Mississippian stratigraphy are Auroraspora, Callisporites, Glomospora, Grandispora, Procoronaspora, Rotospora, Tholisporites, and Tripartites.--Auth.

2-101. Veroda, Victor J. **MISSISSIPPIAN ROCKS OF SOUTHWEST KANSAS (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 172-189, 16 maps, 3 secs., 1959) 3 refs.**

SW. Kansas is situated between 2 regional structural features. They are the Sierra Grande uplift-buried Amarillo Mountain trend to the SW. and the central Kansas uplift to the NE. Mississippian rocks are absent on both features. The Mississippian thickens to 1,800 ft. between these features in what is called the Anadarko basin.

The Mississippian system consists of 4 series. All 4 produce gas and/or oil somewhere in SW. Kansas. There are 7 major Mississippian pools in the area. They range in size from 18 to 56 gas wells and 41 to 239 oil wells. There are many other commercial pools.

The Mississippian produces from both stratigraphic and structural traps. Developmental drilling has revealed 200 ft. of structural relief between 40 acre locations which is the first indication of faulting in the area. Pool studies reveal an erratic occurrence of sands in the basal Chester, a new objective. The Mississippian is still in the pioneer stage of exploration. More major pools will be discovered. --Auth.

2-102. Beebe, B. W. **CHARACTERISTICS OF MISSISSIPPIAN PRODUCTION IN THE NORTHWESTERN ANADARKO BASIN (In: Symposium on the Mississippian of Oklahoma and Kansas: Tulsa Geol. Soc. Digest, v. 27, p. 190-205, 4 maps, 3 secs., 1959) 22 refs.**

Rocks of Mississippian age are important sources of oil and gas in the northwestern Anadarko basin. The most important reservoirs are limestones and dolomites of the St. Louis and Spergen-Warsaw formations, Meramecian in age, and limestones of the Chester. Lenticular sandstones in the lower part of the Chester and limestones in the Ste. Genevieve formation, youngest Meramecian, also afford minor production. Stratigraphic traps in a weathered cherty mantle at the top of the Osagean yield both oil and gas high on the flanks of the basin.

Production from Chesterian strata is principally gas and is widespread in the basin. Accumulation is generally found in stratigraphic traps where secondary porosity has been developed in proximity to the truncating post-Mississippian - pre-Pennsylvanian unconformity. Oil production from Meramecian strata is confined to the northern flank of the basin near the truncated wedge edges of St. Louis and Spergen-Warsaw formations. However, good showings of both oil and gas have been reported from other portions of the basin. The Spergen-Warsaw yielded considerable oil in the discovery well in the Lips field, Roberts County, Texas, deep in the basin.

Although Meramecian production to date has been found on closed anticlinal structures, the development of secondary porosity through leaching by percolating ground waters and dolomitization during the long period of erosion in late Mississippian or early Pennsylvanian time plays an equally important role.

Prospects for additional profitable discoveries of both oil and gas in Chesterian, Meramecian, and Osagean strata appear to be very good. Chesterian discoveries will undoubtedly be made in stratigraphic traps in many parts of the basin where favorable porosity and permeability are found near the truncated top of the series. Additional discoveries of oil and/or gas, not only in structural but in stratigraphic traps, will be made in the Meramecian St. Louis and Spergen-Warsaw formations. The cherty mantle at the top of the Osagean is expected to yield discoveries high on the flanks of the basin where the Keokuk-Burlington formations have been weathered.

In the past, drilling usually has been suspended after penetrating the Chester approximately 100 ft. Although the importance of production from the lower Chesterian and the Ste. Genevieve remains to be demonstrated, discovery of such production will result in more wells penetrating the entire Chesterian section into the Meramecian. Lenticular sandstones in the Kinderhookian, the only Mississippian series not yet productive, offer real promise for discovery in the northwestern Anadarko basin.

Considerable Mississippian production, particularly in the Meramecian, has been found on local closed structure as a result of seismic, surface or core-hole mapping. However, careful, detailed subsurface studies of regional structure, stratigraphy, facies, and geologic history are mandatory to assure that exploration is carried on in the most promising areas.--Auth.

2-103. Nelson, Samuel J., and Harold R. Rudy. **STRATIGRAPHIC POSITION OF THE SHUNDA FORMATION: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 11, p. 257-259, chart, sec., Nov. 1959, 11 refs.**

The type Shunda formation[Mississippian] of the Nordegg area is laterally related to the upper member of the type Banff formation [Mississippian] at Banff, Alberta. It is suggested that the Shunda be considered part of the Banff formation, and that the term "Rundle" be applied to strata overlying the Shunda.--Auth.

2-104. Drummond, James M. **MAJOR DIACHRONISM IN CARBONIFEROUS DEPOSITS OF THE BOW VALLEY AREA, ALBERTA: Alberta Soc. Petroleum Geologists, Jour., v. 7, no. 11, p. 260-266, 2 diags., Nov. 1959, 10 refs.**

Carboniferous sediments in the Bow Valley area of Alberta are represented by 4 major lithostratigraphic units which apparently transgress time horizons towards the W. The 4 rock types involved are interpreted to represent inshore sands (Rocky Mountain formation), lagoonal mud (Etherington and Mount Head formations), crinoid banks (Livingstone formation), and open-sea shales (Banff formation). The distribution of the lithostratigraphic units is related to a gently emergent Carboniferous landmass in the E.

Because of diachronism the paleontology of these Carboniferous rocks will be complicated by the existence of environmentally defined faunal groups of different appearance but of the same age, and other groups of similar appearance but of different ages.--Auth.

2-105. Chisholm, Wayne A. DESCRIBED SECTIONS OF ROCKS OF CHESTER AND MORROW AGE IN NEWTON AND SEARCY COUNTIES, ARKANSAS: U.S. Geol. Survey, Repts., Open-File Ser., 67 p., fold. map, fold. sec., fold. table, Sept. 1959, 7 refs.

This report, one of a series of stratigraphic investigations in northern Arkansas to aid in the search for oil and gas, presents the detailed stratigraphic sections used in correlating and mapping rocks of Chester [Mississippian] and Morrow [Pennsylvanian] age in and adjacent to the Mount Judea and Snowball quadrangles in Newton and Searcy counties. The locations of the sections are shown on an accompanying map, and they are described in relation to topographic and cultural features shown on the topographic maps of the Mount Judea, Snowball, and Marshall (Arkansas) quadrangles and the Harrison (Arkansas-Missouri) quadrangle. A generalized cross section through 8 of the measured sections aligned on the base of the Atoka formation [Pennsylvanian] is included. --From auth. introd.

2-106. Chenoweth, Philip A. A CANYON REEF IN SOUTHERN OKLAHOMA: Oklahoma Geology Notes, v. 20, no. 1, p. 3-6, map, log, Jan. 1960.

The well-known Canyon (Pennsylvanian) reefs of N. and W. Texas have heretofore been tacitly assumed to disappear northward at about the latitude of the Red River. An isolated mound-type reef is situated in the extreme NW. corner of Jefferson County, Oklahoma. The reef is roughly oval, approximately 16 mi. long by 8 mi. wide and attains a maximum thickness of slightly more than 200 ft. At its southwestern end the reef abuts against a pre-Pennsylvanian fault scarp. Late Pennsylvanian folding produced a gentle syncline (Marietta syncline) whose axis crosses the center of the reef nearly at right angles to its longest dimension. Although commonly referred to as "Canyon," the limestone which forms this reef is more properly assigned to the Hoxbar group [Pennsylvanian], stratigraphically between the Daube and Confederate limestones of the Ardmore basin. --Auth.

2-107. Chenoweth, Philip A. SOURCE OF THE VAMOOSA QUARTZITE PEBBLES: Oklahoma Geology Notes, v. 19, no. 11, p. 229-232, map, Nov. 1959, 7 refs.

The Vamoosa formation (Virgilian [Pennsylvanian]) of Seminole County, Oklahoma, contains cobbles and pebbles of quartzite, chert, igneous rock, and brecciated chert in conglomerate beds near the middle of the unit. The quartzite and igneous rocks are assumed to have been eroded from a highland area SE. of Oklahoma. The brecciated cherts most probably were derived from outcrops of the Arkansas novaculite in the area of the present Ouachita Mountains. A large northwestward flowing river system is thought to have drained the highland area, traversing the Ouachita Mountains and joined near the mouth by northward flowing tributaries arising along the Muenster-Waurika arch in N.-central Texas.--Auth.

2-108. Otte, Carel, Jr. LATE PENNSYLVANIAN AND EARLY PERMIAN STRATIGRAPHY OF THE NORTHERN SACRAMENTO MOUNTAINS, OTERO COUNTY, NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Bull. 50, 111 p., 15 figs., 14 pls. (in pocket) incl. 2 geol. maps scale 1:31,680, 1959, 59 refs.

Detailed study of the late Pennsylvanian and early Permian strata in the northern Sacramento Mountains indicated that deposition was essentially continuous in contrast with relationships 4 mi. to the SE., where a major angular unconformity separates Pennsylvanian marine strata from Abo red beds. The beds that are the time-equivalent of the hiatus represented by the unconformity reach a thickness of at least 500 ft. and are named the Laborcita formation. The deposits indicate a gradual emergence of the area, a transition from marine to nonmarine environments, and abrupt lateral changes from open marine conditions to terrestrial flood-plain and piedmont environments to the SE. and E., as shown by lateral tracing of the individual beds.

A typical lateral succession of contemporaneous deposits was found to be: massive marine limestone, nodular argillaceous fusulinid-bearing limestone, silty limestone bearing many molluscs and brachiopods, dolomitic limestone, green shale, red shale, and other terrigenous rocks. Cyclic repetition is locally conspicuous and was related to the tectonic instability of the area and to episodic deformation to the SE.

Fusulinids determined the age of the Laborcita formation as very late Virgilian and early Wolfcampian, with the Pennsylvanian-Permian boundary about 90 ft. above the base of the formation. Preliminary studies of the megafossils by specialists indicate an early Permian age based on brachiopods, but an early late Pennsylvanian age (for the middle part of the formation) based on ammonoids and gastropods.

The Abo red beds intertongue with upper beds of the Laborcita formation and are therefore considered to be largely of middle and late Wolfcampian age. Source of the clastic rocks is considered to be the Pedernal landmass, a positive area extending northward from northeastern Otero County.

A zone of lower Permian algal bioherms occurs NE. of Tularosa in the uppermost Laborcita formation. Detailed studies indicated that the algae probably formed the main sediment-binding organism in these moundlike features which locally stood 60 ft. above the level of contemporaneous sediments.--Auth. and F. E. Kottlowski.

2-109. Chenoweth, Philip A. LATE PALEOZOIC LLANORIAN RIVERS IN OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 11, p. 232-235, 2 maps, Nov. 1959, 3 refs.

During late Pennsylvanian and early Permian time a broad landmass in the region of E. Texas and Louisiana was drained to the N. and NW. by 2 large rivers. The westernmost of these, Permian in age and designated the Duncan River, deposited a delta which compares quite favorably in size with the exposed delta of the Nile. It was apparently a mature stream at time of formation of the delta. The eastern river, called Chert River, deposited sand and gravel in the late Virgil seas, having also followed a northwesterly course. The deltas provide a clue to the size of the rivers, and by inference, the size of the landmass drained by them. It is concluded that this land was of great areal extent.--Auth.

2-110. McKelvey, Vincent E., and others. THE PHOSPHORIA, PARK CITY, AND SHEDHORN FORMATIONS IN THE WESTERN PHOSPHATE FIELD: U.S. Geol. Survey, Prof. Paper 313-A, p. 1-47, 2 maps (1 in pocket), 5 secs., diag. (in pocket), chart (in pocket), 7 tables, 1959, 141 refs.

The Phosphoria formation of Permian age consists mainly of chert, carbonaceous mudstone, and phosphorite at the type locality in southeastern Idaho. These rocks intertongue with and pass laterally into a dominantly sandy sequence in S.-central Montana and northwestern Wyoming and into a dominantly carbonatic sequence in W.-central Wyoming and northeastern Utah, although thin tongues of phosphatic and cherty rocks persist over all these areas. The carbonatic sequence in turn intertongues with and passes laterally into greenish-gray and red beds in eastern Wyoming and southeastern Montana, eastern Utah, and northwestern Colorado. The plan of nomenclature developed to describe these rocks and their relationships has the following as its chief elements: 1) it retains the name "Phosphoria formation" for the chert-mudstone-phosphorite facies and identifies as tongues of the Phosphoria formation rocks of these lithologies that interfinger with sandstone and carbonate rock along the fringe of the phosphate field; 2) it retains the name "Park City formation" (Permian) for the sequence of carbonate rock in Utah, restores this name for similar carbonate rock in W.-central Wyoming, and identifies as tongues of the Park City formation beds of carbonate rock that interfinger with other formations in Idaho, western Wyoming, and Montana; and 3) it introduces the new name "Shedhorn sandstone" for sandstone of Phosphoria age in northwestern Wyoming and adjacent parts of Montana, and identifies as tongues of the Shedhorn the beds of sandstone that interfinger with the Phosphoria and Park City formations in northwestern Wyoming and southwestern Montana.--Auth.

2-111. Waagé, Karl M. **STRATIGRAPHY OF THE INYAN KARA GROUP IN THE BLACK HILLS: U.S. Geol. Survey, Bull. 1081-B, p. 11-90, illus., map, 2 secs., 2 charts, 1959, 70 refs.**

Darton's fourfold subdivision of beds originally called Dakota in the Black Hills [South Dakota] has not proved applicable outside of a limited area in the southeastern Hills in which the names were first applied. Stratigraphic studies of the Inyan Kara group [Lower Cretaceous] reveal a basic twofold lithogenetic subdivision which has been recognized in equivalent beds elsewhere in the western interior region. Deposits of the lower part of this twofold division are dominantly sandy sediments of varied continental facies and are allied lithogenetically with underlying Morrison [Jurassic] beds. Deposits of the upper part are dominantly sandy sediments of marginal marine facies allied lithogenetically, and gradational with the overlying marine Skull Creek shale [Upper Cretaceous]. The contact of the 2 parts is a transgressive disconformity of regional extent marking the initial incursion of the Cretaceous sea.

Subdivision and nomenclature are adjusted to conform to this twofold lithogenetic division by refining the definition of the Fall River formation so that it corresponds to the upper part, and by extending the term Lakota to include the entire lower part. The transgressive disconformity becomes the Lakota-Fall River contact. The Inyan Kara group is retained to include these 2 formations. The Minnewaste limestone is recognized as a local member of the Lakota and use of the name Fuson as a member of the Lakota is considered permissible only where the Minnewaste limestone is present.

A stratigraphic summary serves to reveal the great variability of Inyan Kara rocks and to highlight local peculiarities and problems in the Lakota and Fall River beds.--Auth.

5. PALEONTOLOGY

See also: Stratigraphy 2-88, 2-89, 2-90, 2-100, 2-104.

2-112. Harnack, Curt. **TREASURES FROM AN ANCIENT SEA: Earth Sci., v. 12, no. 5, p. 153-156, 166, 3 illus., Oct. 1959.**

The career and fossil collecting activities of Dr. B.H. Beane, paleontologist and expert in crinoids is reviewed. His Mississippian echinoderm specimens from the Le Grand, Iowa, quarry are world famous.--M. Russell.

2-113. MacNeil, Marion Gill, and Robert P. MacNeil. **ON THE FACE OF THE EARTH: 72 p., illus., New York, Henry Z. Walck, 1959, 21 refs.**

Written for children ages 8 to 12, this volume attempts to summarize the history of life on earth. --M. W. Pangborn, Jr.

2-114. Darling, Lois, and Louis Darling. **BEFORE AND AFTER DINOSAURS: 95 p., illus., map, diags., New York, William Morrow, 1959.**

Written for children ages 10 to 14, this is a history of the Reptilia during the Mesozoic, including a summary of their rise in the late Paleozoic. The authors stress the anatomical and physiological innovations which figured in the development of the various reptile groups.--M. W. Pangborn, Jr.

2-115. Branson, Carl C. **LOCAL FOSSIL ASSEMBLAGE IN THE SEMINOLE FORMATION: Oklahoma Geology Notes, v. 20, no. 1, p. 16-17, Jan. 1960, 6 refs.**

A small fossiliferous outcrop of the Seminole formation (early Missourian, Pennsylvanian) yielded 1,305 identifiable invertebrate fossils. The biofacies is a molluscan-brachiopod-crinoidal assemblage, notable for the sparsity of corals and bryozoans, and lacking in fusulinids.--Auth.

2-116. Strimple, Harrell L. **THE OCCURRENCE OF GALATEACRINUS ALLISONI IN OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 9, p. 195-196, Sept. 1959, 6 refs.**

The rare crinoid genus *Galateacrinus* is recorded from the Wann formation [Pennsylvanian] of Washington County, Oklahoma. The specimen displays some features not preserved in the holotype of *G. allisoni*. --C. C Branson.

2-117. Boardman, Richard S. **A REVISION OF THE SILURIAN BRYOZOAN GENUS TREMATOPORA: Smithsonian Inst., Smithsonian Misc. Colln., v, 139, no. 6, 14 p., 2 illus., diag., 2 tables, Oct. 1959, 12 refs.**

A restudy of the type species of *Trematopora* shows that the genus is characterized in part by

mesopores of fundamentally different modes of growth in inner and outer regions of the mature zone. In the inner region, continuity of mesopore walls with diaphragms, single central pores through diaphragms, and transversely laminated diaphragm structure indicate that depositing tissue occurred on both sides of growing diaphragms. In the outer region, laminated structures indicate that depositing tissue functioned only on the outer sides of the greatly thickened mesopore diaphragms. The revised generic concept limits the stratigraphic occurrence of the genus to the Middle Silurian.--Auth.

2-118. Emerson, William K., and Emery P. Chace. PLEISTOCENE MOLLUSKS FROM TECOLOTE CREEK, SAN DIEGO, CALIFORNIA: San Diego Soc. Nat. History, Trans. v. 12, no. 21, p. 335-346, 3 figs., May 1959, 30 refs.

A molluscan assemblage, totaling 69 extant and 1 extinct species, is reported from a previously unrecorded fossiliferous marine terrace locality. Several new records for locally extinct thermophilic species are recorded for the Pleistocene fauna of this area. The composition of the fauna is compared with similar local terrace faunas. The age of the fauna is inferred to be later than early Pleistocene and earlier than Wisconsin time.--W. K. Emerson.

2-119. Emerson, William K. THE GASTROPOD GENUS PTERORYTIS: Am. Mus. Nat. History, Am. Mus. Novitates, no. 1974, 8 p., 4 figs., Nov. 1959, 13 refs.

The following taxa referable to the muricid genus Pterorytis Conrad, 1862, are reviewed: Pterorytis (Pterorytis) umbrifer (Conrad, 1832), Pterorytis (Neurarhytis) fluviana (Dall, 1903), Pterorytis (Neurarhytis) conradi (Dall, 1890), and Pterorytis (Neurarhytis) marshalli (Mansfield, 1930). Microrhytis is proposed as a new subgenus with Pterorytis (Microrhytis) pecki n. sp., from the Miocene (? Coatzocoalcos formation) of Veracruz, Mexico, designated the type species.--Auth.

2-120. Sutherland, Patrick K., and Thomas W. Amsden. A RE-ILLUSTRATION OF THE TRILOBITE LONCHODOMAS MCGEHEEI DECKER FROM THE BROMIDE FORMATION (ORDOVICIAN) OF SOUTHERN OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 10, p. 212-219, 7 illus., map, Oct. 1959, 5 refs.

The trilobite Lonchodomas mcgeheei Decker is redescribed based on the holotype, here reillustrated, and on 4 almost complete topotypes which are illustrated for the first time. Included is the first detailed geologic map to be published of the local area around Rock Crossing, the type locality of this species, located in the Criner Hills of southern Oklahoma. The map shows particularly the surface exposures of the Ordovician Bromide and Viola formations.--P. K. Sutherland.

2-121. Holman, J. Alan. BIRDS AND MAMMALS FROM THE PLEISTOCENE OF WILLISTON, FLORIDA: Florida State Mus., Bull., Biol. Sci., v. 5, no. 1, 24 p., 2 illus., 11 tables, 1959, 18 refs.

A Pleistocene vertebrate locality at Williston, Levy County, contained the remains of 6 species of birds and 20 of mammals. The bones were in Arredondo clay, of Illinoian age, in a solution pipe in the Eocene Ocala limestone.

Two birds are extinct, a large quail (Colinus suilium), and a large jay (Henocitta brodkorbi) which is described as new. Six mammals are extinct: a mustelid of uncertain identity, a pine vole (Pitymys hibbardi) which is described as new, an armadillo (Dasypus beltus), a tapir (Tapirus veroensis), a peccary (Mylohyus sp.), and a horse (Equus sp.). Rabbits of the genus Sylvilagus are represented by 561 fossil elements; in many cases the 2 species, S. palustris and S. floridanus, can be distinguished on cranial and postcranial bones.

The Pleistocene habitat of the Williston area was probably marshy pineland grading into well drained pineland with open sinks, surrounded by mesophytic vegetation.

Six species, 23% of the fossil fauna, are larger than their Recent Florida representatives. Five of these 6 species have larger modern forms to the N. Applying Bergmann's rule, this supports the thesis that Florida had a somewhat cooler climate in the Illinoian glacial stage.

The Williston fauna differs from other Pleistocene localities in Florida in its low percentage of extinct mammals. This is because a large number of the Williston mammals are small. If the percentage of extinction is calculated separately for large and small size classes, the Williston fauna resembles that of other Florida Pleistocene localities more closely.--Auth.

2-122. Wells, Patrick H. BEAR BONES FROM A BOONE COUNTY CAVE: Natl. Speleol. Soc., Bull., v. 21, pt. 1, p. 13-14, 3 illus., Jan. 1959.

Native bear population of Missouri became extinct during the 1800's and the bears now in the Ozarks were introduced about 15 years ago. A fissure cave in Boone County recently excavated by William Elder, Professor of Zoology, University of Missouri, has yielded many late Quaternary bones. Among them are the skeletons of 6 bears. The bears were black bears but their skeletons show they were much larger than modern black bears. Teeth were strikingly oversized in keeping with the other skeletal parts that were proportionally heavy. --Auth.

2-123. Takai, Fuyuji. ON CENOZOIC VERTEBRATES IN KOREA. Translated by author: Internat. Geology Rev., v. 1, no. 10, p. 47-51, Oct. 1959, 33 refs.

Cenozoic fossil mammals, relatively rare in Korea, were first discovered there in 1915 by K. Jimbo and identified as possibly Pleistocene horse and rhinoceros remains. Subsequently, 7 mammalian species of Eocene Carnivora and Perissodactyla were found in the Pongsan coal fields. Miocene fossils discovered include 4 vertebrate species; the most extensive occurrences are represented by the Pleistocene. Of 19 mammalian species, 15 were taken from a single terrace deposit. Correlation with other far eastern fossil localities is attempted where sufficient data was available. Tentative identifications are made of an elephantine tooth and a sabre-toothed tiger, both Pleistocene. Specimens from Tungryong-gul limestone cave are probably too recent to be properly designated fossils.--D. D. Fisher.

2-124. Livingston, Vaughn E., Jr. FOSSILS IN WASHINGTON: Washington, Div. Mines & Geology,

nf. Circ. no. 33, 35 p., 17 illus., map, table, 1959, approx. 40 refs.

The introductory section of this booklet, written xpressly for the layman, briefly discusses geologic ime divisions, methods of fossilization, strati- raphic and ecologic value of fossils, and classifica- ion. A geologic time table is included.

The major portion of the booklet is divided into ections, each dealing with a geologic period. Each period except Silurian is represented by fossils in Washington. Fossil-bearing rocks and fossil localities are given in each section as well as line drawings of fossils. Pertinent references follow each section, and an index map of fossil localities in Washington is included.

A final section briefly discusses methods of collecting and the importance of recording fossil locations. A list of selected references for further reading is appended.--W. H. Reichert.

6. GEOPHYSICS

ee also: Geologic Maps 2-16 through 2-34; Igneous nd Metamorphic Petrology 2-190.

-125. Chapman, Sydney. IGY: YEAR OF DIS- OVERY: THE STORY OF THE INTERNATIONAL EOPHYSICAL YEAR: 111 p., illus., maps, Ann rbor, Michigan, University of Michigan Press, 959.

A popular account of some of the scientific aspects f the 1957-1958 International Geophysical Year, ased on 4 lectures given at the University of Michigan by the author, President of the IGY. Among subjects concisely reviewed are earthquake waves, laciers, oceans, the atmosphere, the aurora, eomagnetism, and cosmic rays. A final chapter ummarizes the organization and accomplishments f the IGY.--M. W. Pangborn, Jr.

-126. Eaton, Jerry P. A PORTABLE WATER- UBE TILTMETER: Seismol. Soc. America, Bull., . 49, no. 4, p. 301-316, 7 figs. incl. map, diags., raphs, Oct. 1959, 6 refs.

The accumulation of magma within a volcano eforms the ground surface around it. Although endulum-type tiltmeters are our most sensitive nd convenient tool for detecting such deformations, heir records are generally difficult to interpret ecause purely local disturbances obscure the subtle hanges produced by the volcano.

A new tiltmeter consisting of a permanent tilt ase and a portable water-tube leveling system was eveloped to measure tilting around Kilauea caldera. ecause the tilt bases for this instrument are on the round surface outdoors, the leveling system must e operated under conditions that are far from ideal. f the work is performed at night and if a carefully tandardized procedure is followed, leveling can be arried around a circuit consisting of 3 piers at the ertices of a triangle 2,000 in. on a side with a losure error of less than 10μ (corresponding to an rror in the measurement of tilt of less than 0.2 X 0^{-6} radian).

Tilting at 4 new tilt bases around Kilauea caldera etween Oct. 1958 and Feb. 1959 shows that the ummit of the volcano is swelling. An analysis of he tilting around the caldera suggests that magma s accumulating in a reservior about 4 km. beneath he SW. end of the caldera.--Auth.

-127. Whitten, Charles A., and Kenneth H. Drum- mond, eds. CONTEMPORARY GEODESY. Proceed- ngs of a Conference Held at the Harvard College Observatory - Smithsonian Astrophysical Observato- y, Cambridge, Massachusetts, December 1-2, 958: Am. Geophys. Union, Geophys. Mon. no. 4 Natl. Acad. Sci.-Natl. Research Council, Pub. no. 708), 95 p., illus., maps, diags., graphs, tables, 1959, refs.

Fourteen papers are grouped under 3 main headings - geodetic fundamentals, problems of modern geodesy, and geodesy and space; each section has its own introduction, and most papers are followed by discussion. The contents are listed below; the papers with capitalized titles are abstracted separately in the order in which they appear in the book.

2-128. Ewing, Maurice, J. Lamar Worzel, and Manik Talwani. SOME ASPECTS OF PHYSICAL GEODESY (In: Whitten, Charles A., and Kenneth H. Drummond, eds. Contemporary Geodesy...: Am. Geophys. Union, Geophys. Mon. no. 4, p. 7-21, 2 maps, 4 diags., 3 graphs, seismogram, 1959) 17

refs.; also pub. as: Columbia Univ., Lamont Geol. Observatory, Contr. no. 357.

Methods are proposed for establishment of bench marks in the ocean that would be the basis of intercontinental geodetic ties. These would form the base stations for location of secondary points anywhere in the ocean. The distance between such bench marks can probably be measured with an accuracy of one part in 200,000, as required for first order geodetic work. The bench marks would be made by placing a transponder at the corners of an equilateral triangle; a ship within the triangle can transmit acoustic signals which the transponders can repeat back without delay. The bench mark would be defined as the point on the water's surface from which the round trip travel time to all 3 vertices is equal.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-129. Meade, Buford K. GEODETIC NETWORKS (In: Whitten, Charles A., and Kenneth H. Drummond, eds. Contemporary Geodesy...: Am. Geophys. Union, Geophys. Mon. no. 4, p. 30-35, diag., 1959)

The factors entering into establishment of a natural geodetic control system are discussed. By obtaining sufficient ties between continential datums already established, and by cooperation from all countries involved, a new world datum including all networks would furnish valuable information concerning the shape and size of the earth.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-130. Braaten, Norman F. ORTHOMETRIC, DYNAMIC, AND BAROMETRIC HEIGHTS (In: Whitten, Charles A., and Kenneth H. Drummond, eds. Contemporary Geodesy...: Am. Geophys. Union, Geophys. Mon. no. 4, p. 36-39, 1959)

Orthometric elevations, used in most engineering work, are defined as geometric heights above the geoid surface. Because level surfaces at different altitudes are not parallel, the orthometric concept has disadvantages. The dynamic system, in which each level surface is given a number of its own proportional to the work required to raise a unit mass from sea level to that surface, offers an alternative. The International Association of Geodesy has recently recommended that each country compute and adjust its leveling network on a dynamic basis referred to surface measurements of gravity to provide values adequate for scientific work, then convert these to orthometric values for general use.

When the U. S. Coast and Geodetic Survey will adopt this recommendation depends on how soon gravity is measured along all leveling routes. A releveling program is also necessary

In an absolutely calm atmosphere a particular isobaric surface would coincide with a level surface of particular isobaric number; dynamic heights therefore are often determined from barometric heights in upper atmosphere studies.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-131. Rice, Donald A. GRAVITY AND GRAVITY REDUCTION (In: Whitten, Charles A., and Kenneth H. Drummond, eds. Contemporary Geodesy...: Am. Geophys. Union, Geophys. Mon. no. 4, p. 40-44, 1959)

A gravity measurement by itself is hardly useful in geodesy; before the Stokes formula can be applied, the surface gravity measurements must be transferred to the geoid whose shape is being measured. Corrections must be calculated for the effect of masses above sea level, either by abolishing them, condensing them on the geoid, or transferring them within it. To date most large-scale applications of the Stokes formula have used the condensation reduction; its chief disadvantage is that gravity anomalies tend to be strongly correlated with topography, and close station spacing is necessary to obtain good anomaly averages in highly dissected regions.

There are theoretical weaknesses in all the conventional reductions. The new approach is to use gravity data directly as observed on the physical boundary of the earth. For convenience the physical surface would be smoothed without changing the total mass. The anomalies would be gotten by comparison with theoretical gravity projected upward, using geopotential height measurements. Under these conditions the integral formulas would ultimately yield the form of the smoothed physical surface of the earth with respect to the ideal gravity model; the earth's shape would be better defined, and gravimetric deflections of the vertical would be comparable to astrogeodetic deflections observed on the ground.--D. B. Vitaliano (courtesy Geophysical Abstracts).

2-132. Thiel, Edward, Ned A. Ostenso, William E. Bonini, and G. P. Woollard. GRAVITY MEASUREMENTS IN ALASKA: Arctic, v. 12, no. 2, p. 66-76, 5 maps, profiles, 3 tables, June 1959, 4 refs.

Over the past several years a network of 513 gravity stations has been established in Alaska and Yukon Territory by personnel from the University of Wisconsin. This network includes traverses over most of the highways, the Alaska Railroad, and the Lewes-Yukon River. Less accessible areas were reached by single-engine aircraft. All values are adjusted to the Potsdam datum through reoccupation of pendulum stations at Fairbanks and Whitehorse. The Free Air and Bouguer anomalies for densities of 1.77, 2.00, 2.20, 2.40, 2.50, 2.67, 2.80 and 2.90 were computed on a IBM 650 digital computer.

This work was undertaken primarily to provide a widespread unified datum for future gravity surveys. Although the areal coverage is not sufficient for constructing a gravity map of the entire state, regional gravity maps are presented for SE. Alaska and part of the northern coastal plain. Correlation of gravity and geology is made by means of profiles and by superposition of anomaly values on a geological map.--E. Thiel.

2-133. Whitham, Kenneth, E.I. Loomer, and E. Dawson. RECENT STUDIES OF THE NORTH MAGNETIC DIP POLE: Arctic, v. 12, no. 1, p. 28-39, 2 maps, 2 graphs, March 1959, 20 refs.

The position of the N. magnetic dip pole for the epoch 1960.0 has been estimated at 74.8°N. 99.6°W, between Bathurst and Prince of Wales Island. Using the results from Resolute [Cornwallis Island] magnetic observatory and from recent regional arctic surveys, its present secular drift is found to be 5.5 mi. per year very slightly E. of N. A brief survey of the pole determinations which are known to us is brought up to date, and the geophysical significance of the pole and its secular motion is discussed.--K. Whitham.

2-134. Socolow, Arthur A. GEOLOGIC INTERPRETATION OF THE AEROMAGNETIC MAP OF

HE VALLEY FORGE QUADRANGLE: Pennsylvania eol. Survey, Inf. Circ. 18, 4 p., 1959, 2 refs.

Variation of magnetic pattern over different rock nits in the Valley Forge quadrangle is discussed. our magnetic anomalies in the quadrangle are valuated and considered to be of noneconomic sig- ificance.--Auth.

For map see Section 1. Geologic Maps.

-135. Socolow, Arthur A. GEOLOGIC INTER- RETATION OF THE AEROMAGNETIC MAP OF HE NORRISTOWN QUADRANGLE: Pennsylvania eol. Survey, Inf. Circ. 19, 3 p., 1959, 2 refs.

Three position magnetic anomalies are related to ocal lithologic varieties and are not considered to e of economic significance.--Auth.

For map see Section 1. Geologic Maps.

-136. Socolow, Arthur A. GEOLOGIC INTER- RETATION OF THE AEROMAGNETIC MAP OF HE MALVERN QUADRANGLE: Pennsylvania Geol. urvey, Inf. Circ. 20, 4 p., 1959, ref.

A 3-fold division of the magnetic pattern over the Malvern quadrangle is related to specific lithologic roups. Two positive magnetic anomalies are re- ated to local rock types and are considered to be f noneconomic significance.--Auth.

For maps see Section 1. Geologic Maps.

-137. Socolow, Arthur A. GEOLOGIC INTER- RETATION OF THE AEROMAGNETIC MAP OF HE WEST CHESTER QUADRANGLE: Pennsylvania eol. Survey, Inf. Circ. 21, 4 p., 1959, ref.

The variation in magnetic patterns in the West hester quadrangle are found to correspond with the stribution of major rock types. Three positive agnetic anomalies are related to local rock types ut neither field checking nor the literature yield an xplanation for 3 other such anomalies. The latter offer more of an academic challenge than any like- hood of economic significance.--Auth.

For map see Section 1. Geologic Maps.

-138. Socolow, Arthur A. GEOLOGIC INTER- RETATION OF THE AEROMAGNETIC MAP OF HE MEDIA QUADRANGLE: Pennsylvania Geol. urvey, Inf. Circ. 22, 4 p., 1959, ref.

Variation in magnetic pattern in the Media quad- angle is related to lithologic types. Seven positive agnetic anomalies are related to local rock com- osition, and none are considered as having favor- ble economic possibilities.--Auth.

For map see Section 1. Geologic Maps.

-139. Socolow, Arthur A. GEOLOGIC INTER- RETATION OF THE AEROMAGNETIC MAP OF HE EAST GREENVILLE QUADRANGLE: Pennsyl- ania Geol. Survey, Inf. Circ. 23, 7 p., 1959, 2 efs.

The general variation in magnetic pattern is elated to the distribution of the major rock types. magnetic anomaly of over 2,000-gamma amplitude ccurs over the old Rittenhouse Gap Fe mines, and earby are 2 other anomalies of over 1,000 gammas mplitude; exploration for economic concentrations Fe ore is suggested at these sites. Ten other sser anomalies are related to local lithologic atures and old Fe prospects, but are not considered to be of economic significance.--Auth.

For map see Section 1. Geologic Maps.

2-140. Socolow, Arthur A. GEOLOGIC INTER- PRETATION OF THE AEROMAGNETIC MAP OF THE MILFORD SQUARE QUADRANGLE: Pennsyl- vania Geol. Survey, Inf. Circ. 24, 4 p., 1959, 2 refs.

The relationship of certain magnetic patterns with specific lithologic types in the quadrangle is established. Eight positive magnetic anomalies are related to local variations in lithology, but none are considered to be of economic significance.--Auth.

For map see Section 1. Geologic Maps.

2-141. Socolow, Arthur A. GEOLOGIC INTER- PRETATION OF THE AEROMAGNETIC MAP OF THE SASSAMANSVILLE QUADRANGLE: Pennsyl- vania Geol. Survey, Inf. Circ. 25, 4 p., 1959, 2 refs.

The general relationship of magnetic patterns with lithologic types in the quadrangle is described. Three positive magnetic anomalies are related to specific geologic features, but there is no indication that they denote economic concentrations of Fe ore. --Auth.

For map see Section 1. Geologic Maps.

2-142. Socolow, Arthur A. GEOLOGIC INTER- PRETATION OF THE AEROMAGNETIC MAP OF THE PERKIOMENVILLE QUADRANGLE: Pennsyl- vania Geol. Survey, Inf. Circ. 26, 4 p., 1959, 2 refs.

The contact of magnetic patterns over Triassic sediments, diabase, and metamorphic zones is described. Two positive magnetic anomalies are described and related to contact metamorphic ef- fects.--Auth.

For map see Section 1. Geologic Maps.

2-143. Socolow, Arthur A. GEOLOGIC INTER- PRETATION OF THE AEROMAGNETIC MAP OF THE PHOENIXVILLE QUADRANGLE: Pennsylvania Geol. Survey, Inf. Circ. 27, 3 p., 1959, ref.

The Phoenixville quadrangle consists chiefly of Triassic sediments which exhibit uniform magnetic intensity and no anomalies.--Auth.

For map see Section 1. Geologic Maps.

2-144. Socolow, Arthur A. GEOLOGIC INTER- PRETATION OF THE AEROMAGNETIC MAP OF THE ALLENTOWN QUADRANGLE: Pennsylvania Geol. Survey, Inf. Circ. 28, 7 p., 1959, 3 refs.

The variation in magnetic patterns in this quad- rangle serves to delineate major lithologic and struc- tural units. The 1,800-gamma amplitude anomaly over the old Fe mine at Vera Cruz suggests that there is a significant concentration of magnetite which is worthy of exploration. An anomaly 9 mi. long in the northern part of the quadrangle is attri- buted to the deeply buried basement. A large number of smaller anomalies associated with gneisses are evaluated and considered to be of no economic signif- icance.--Auth.

For map see Section 1. Geologic Maps.

2-145. Socolow, Arthur A. GEOLOGIC INTER- PRETATION OF THE AEROMAGNETIC MAP OF

THE QUAKERTOWN QUADRANGLE: Pennsylvania Geol. Survey, Inf. Circ. 29, 4 p., 1959, 2 refs.

The magnetic patterns over Triassic sediments, diabase, and contact zones in the quadrangle are described. Four anomalies over contact areas are evaluated and considered to be of no economic significance.--Auth.

For map see Section 1. Geologic Maps.

2-146. Socolow, Arthur A. **GEOLOGIC INTERPRETATION OF THE AEROMAGNETIC MAPS OF THE BUCKINGHAM, LAMBERTVILLE, AND STOCKTON QUADRANGLES: Pennsylvania Geol. Survey, Inf. Circ. 30, 5 p., 1959, 3 refs.**

Large anomaly over Buckingham Mountain is believed due to upthrown basement block, but anomaly at northeastern end of the mountain may represent extensive magnetite at fairly shallow depth. Distinct anomalies show over Solebury and Jericho mountains, both diabase ridges.--Auth.

For map see Section 1. Geologic Maps.

2-147. Socolow, Arthur A. **GEOLOGIC INTERPRETATION OF THE AEROMAGNETIC MAP OF THE SAFE HARBOR QUADRANGLE: Pennsylvania Geol. Survey, Inf. Circ. 31, 4 p., 1959, 2 refs.**

The relationship of magnetic pattern to lithology is indicated in this quadrangle. Several positive anomalies occur over local magnetite in the Wissahickon schist, but none approach economic proportions.--Auth.

For map see Section 1. Geologic Maps.

2-148. Socolow, Arthur A. **GEOLOGIC INTERPRETATION OF THE AEROMAGNETIC MAP OF THE CONESTOGA QUADRANGLE: Pennsylvania Geol. Survey, Inf. Circ. 32, 4 p., 1959, 3 refs.**

The variation in magnetic patterns in this quadrangle is related to general lithologic types. Three positive magnetic anomalies of considerable amplitude occur over Antietam-Harpers schist. Further exploration for magnetite may be warranted at these locations, particularly since an Fe mine once did operate near one.--Auth.

For map see Section 1. Geologic Maps.

2-149. Socolow, Arthur A. **GEOLOGIC INTERPRETATION OF THE AEROMAGNETIC MAP OF THE QUARRYVILLE QUADRANGLE: Pennsylvania Geol. Survey, Inf. Circ. 33, 4 p., 1959, 2 refs.**

The magnetic patterns in this quadrangle tend to vary with the general nature of the underlying rock types. A distinctive anomaly of considerable amplitude occurs over a complex area of Antietam-Harpers schist. A magnetite concentration is indicated and further exploration may be warranted.--Auth.

For map see Section 1. Geologic Maps.

2-150. Socolow, Arthur A. **GEOLOGIC INTERPRETATION OF THE AEROMAGNETIC MAP OF THE MORGANTOWN QUADRANGLE: Pennsylvania Geol. Survey, Inf. Circ. 34, 4 p., 1959, 4 refs.**

The variation in magnetic pattern over a diabase dike, a large magnetite ore body, and a thick Triassic section are well illustrated. The anomaly over Bethlehem Steel Company's Grace mine is an outstanding example. No other ore bodies of economic scope are indicated in the quadrangle.--Auth.

For map see Section 1. Geologic Maps.

2-151. Socolow, Arthur A. **GEOLOGIC INTERPRETATION OF THE AEROMAGNETIC MAP OF THE ELVERSON QUADRANGLE: Pennsylvania Geol. Survey, Inf. Circ. 35, 5 p., 1959, 3 refs.**

The magnetic pattern in the quadrangle varies with the general rock type. A number of small but distinct positive anomalies occur over the sites of some former Fe mines, indicating some magnetite was left in each, but no really significant amounts. One larger anomaly indicates a probable magnetite body N. of Warwick.--Auth.

For map see Section 1. Geologic Maps.

2-152. Turnbull G. **SOME PALAEOMAGNETIC MEASUREMENTS IN ANTARCTICA: Arctic, v. 12, no. 3, p. 151-157, 3 diags., tables, Sept. 1959, 9 refs.**

Mean directions of magnetization determined for certain rock formations in Victoria Land are briefly reported. The magnitude and direction of the magnetization of rock discs were measured with a sensitive astatic magnetometer.

It is assumed that the secular variation of the earth's magnetic field is averaged out by the sampling procedure and that the mean field so represented is that of an axial dipole at the geocenter. Thus the position of the geographic axis with respect to the earth's crust is inferred for the time at which the rocks became magnetized; subject to certain restrictions this may be taken as the time at which they were formed.

Cenozoic volcanics from the Cape Hallett area show a reversed magnetization which suggests a pole near the present axis, 81°S. 94°E. The area of 95% uncertainty just fails to include the present geographic pole.

Dolerites of probable Jurassic age, sampled from the sills in the Ferrar glacier region, imply a pole position for this epoch at 58°S. 142°W., some 32° away from the present axis. Polar wandering is thus implied. Specimens of an argillaceous red sandstone collected in the same area display an almost identical direction of magnetization. This is interpreted as a partial thermo-remanent magnetization acquired by heating when the intrusions were emplaced.--Auth.

2-153. Wait, James R., ed. **OVERVOLTAGE RESEARCH AND GEOPHYSICAL APPLICATION: 160 p., 40 illus., New York, Pergamon Press, 1959, 50 refs.**

The monograph contains a collection of papers dealing with the subject of overvoltage (or induced electrical polarization) as it is related to geophysical exploration. The phenomenon is extremely complex in nature and is not as yet well understood. However, it appears to be electrochemical in origin and is associated with dispersion of the electrical properties of rocks, soils, and clays as a function of frequency or time.

The basic field procedure developed in 1948 entails the passage of a direct current through the medium for a fraction of a minute, the abrupt interception of the current, and the subsequent measurement of the decay of the voltages in the medium. A group at Newmont Exploration Ltd. under the super-

vision of A. A. Brant have been extremely active in this field in the last decade, and the present monograph is essentially a consolidated report of their findings.

Chap. 1. A. A. Brant describes the history of Newmont's interest in the subject. He concludes that, if used in the proper environment, the overvoltage method can be a powerful tool for detecting scattered sulfide mineralization. In older rock areas, however, background effects become large and irregular and "anomalies are frequently spurious."

Chap. 2. H. O. Seigel develops a mathematical representation to predict the dependence of the observed transient voltages on the physical properties of the materials. It is indicated that the action of the primary field is to set up a volume distribution of current dipoles anti-parallel to the field. The current moment of these dipoles is proportional to the primary current density. The factor of proportionality is called the "chargeability" m and is a property of the medium. It is shown that for any homogeneous medium the peak voltage of the transient decay is proportional to the chargeability m of the medium. Using potential theory, Seigel shows how the overvoltage response characteristic for heterogeneous media is related to the resistivity and chargeability factors of the basic constituents. The theoretical interpretation is demonstrated by applying it to actual field data.

Chap. 3. J. R. Wait presents a phenomenological theory for alternating current flow in mineralized rocks. It is assumed that the structure can be represented by a homogeneous medium loaded with a distribution of conductive particles of spherical shape, each coated with a dielectric film. Transient conditions are also considered. The results explain, at least in a qualitative way, the observed features of overvoltage response. In particular, the influence of particle size on the shape of the transient decay curves is explained.

Chap. 4. J. R. Wait discusses data concerning the variation of the complex conductivity of mineralized media over a frequency range from 0.1 to 10^5 c/s. The mathematical relation between a frequency dependent conductivity and the transient overvoltage responses is then derived. This interrelation is demonstrated by an example which is verified experimentally. In the second part of this chapter, electromagnetic propagation and interwire coupling effects are discussed briefly from the standpoint of their masking effect on the overvoltage measurement when a 4-electrode array is employed. In the third part, results from a preliminary field trial of the frequency variation method carried out in the summer of 1950 in the vicinity of Jerome, Arizona, are described.

Chap. 5. L. S. Collett discusses the techniques used for laboratory studies of induced polarization in mineralized and nonmineralized rock specimens. The equipment for both the transient and the frequency variation procedures is described in outline. Many experimental results are presented for both field and standard samples.

Chap. 6a. The progress in the analysis of induced polarization decay curves on rock specimens is described by J. R. Wait. The curves analyzed are those taken by Collett with the standard accepted technique including the electro-osmosis treatment described in Chap. 5. Particular attention is paid to the examination of the curve shape. For this purpose the first, second, and third derivatives are evaluated and shown plotted against the magnitude of the response in each case. Several other interesting properties of the decay curves are also investigated. In a sequel to this chapter, N. F. Ness discusses briefly the corresponding analysis for frequency response data of mineralized and nonmineralized samples. He tends to be pessimistic and concludes that there are no well defined characteristic differences of spectrum behavior that can be utilized to predict the presence of metallic particles.

Chap. 7. G. V. Keller discusses the Newmont data for the transient decay curves in a somewhat different fashion. He displays the results in terms of the density of relaxation times. Thus he imagines the induced polarization to be a superposition of a large number of simple exponential forms. He concludes the most active rocks are those containing electronic conductors such as base-metal sulfides or hematite. Here, the polarization is most probably the electrode type polarization. The next most active group of rocks are the clay-bearing sediments, where polarization probably arises from ion barriers in the pore structure. The least active of the major groups of rocks are the limestones and silicic igneous rocks which ordinarily contain insignificant amounts of either clay or metallic minerals, and polarization may take place by electrokinesis, the least efficient of the polarization mechanisms. A few odd samples containing metallic minerals and having very low resistivities show by far the least polarization. It is fairly evident from the resistivity that these rocks contain massive or continuous, rather than disseminated, electronic conductors. Since the metallic phase is continuous, much of the current flow is through that phase, rendering the ionic polarization mechanisms unimportant, and, at the same time, reducing the electrode polarization effect because of the small specific surface area through which current enters the metallic phase from the ionic phase.

Chap. 8. A very brief description of the field equipment is given by K. A. Ruddock.

Chap. 9. The success of the overvoltage or induced polarization method in delineating sulfide mineralization associated with porphyry coppers is described by R. S. Baldwin. Examples are shown from San Manuel, Arizona, and from Cuajone and other Peruvian prospects. Examples of response from other types of mineralization are given from Lynn Lake, Manitoba, and from South Africa. Further mention is made of extraneous responses due to nonsulfides.

Chap. 10. The so-called normal effect is discussed in some detail by V. Mayper. This is the background signal which may obscure the overvoltage response from the sulfide mineralization. Various explanations of the normal effect are considered. Induced-polarization experiments are described, in which no normal effect whatever is obtained from "clean" artificial porous samples. Details of the experiments are given. The conclusion is drawn that, of the hypotheses so far advanced, the only ones still allowable are that the effect is due to a current-induced disequilibrium in the electrochemical properties of particles in the rock pores (probably ion exchange in clay), or that it is due to the presence of very slight true conductivity in some "nonconducting" minerals. Hypotheses involving electrokinetic effects, air bubbles, or surface conduction have been rejected.

It is concluded that the normal effect is caused by electrochemical phenomena within and on the surface of particles of clay and claylike deteriorated

mica in a rock. In addition the presence of unrecognized conducting minerals has often caused effects indistinguishable from the normal effect. The anomalously high normals are ascribed to pore-structure effects in tight rocks, or to the prescence of large amounts of unrecognized active material.

These conclusions are arrived at principally on the basis of assays, petrographic analyses, porosity measurements, resistivity measurements, and critical experiments on a number of samples. The critical experiments consisted largely of measurements of induced-polarization response before and after the attempted elimination of clay by heating and by electrodialysis.--Ed. abs

2-154. Hessler, V.P., and A.R. Franzke. EARTH-POTENTIAL ELECTRODES IN PERMAFROST AND TUNDRA: Arctic, v. 11, no. 4, p. 211-217, illus., diag., 4 graphs, 1958, pub. 1959.

Lead sheet electrodes with area of about 4 sq. ft. were installed in the permafrost and tundra area of Pt. Barrow [northern Alaska] in autumn 1955. The original electrode resistances ranged from 100 to 400 ohms.

The resistance values increased with freezeup and continued to increase with lowering ground temperatures. The maximum resistance of 194,000 ohms occurred at a ground temperature of -12°F. at the electrode depth. The electrode resistance returned to the original low values in the summer of 1956.

A second set of electrodes consisting of 50-ft. lengths of 4-in. wide lead strip in a 16-ft. diameter circular trench were installed in the summer of 1956. One hundred pounds of sodium chloride was incorporated in the fill material. These electrodes have maintained winter resistance values below 5,000 ohms for 3 succeeding winters.--V. P. Hessler.

2-155. Lehner, Francis E. AN ULTRA-LONG-PERIOD SEISMOGRAPH GALVANOMETER: Seismol. Soc. America, Bull., v. 49, no. 4, p. 399-401, 5 figs. incl. illus., diag., Oct. 1959,; also pub as: California Inst. Technology, Div. Geol. Sci., Contr. no. 925.

A brief description is given of a galvanometer of longer than ordinary period. Mention is made of some of the details, precautions, and techniques pertaining to its construction, testing, and operation. The discussions are applicable to galvanometers of extended period in general.--Auth.

2-156. Scheidegger, Adrian E. STATISTICAL ANALYSIS OF RECENT FAULT-PLANE SOLUTIONS OF EARTHQUAKES: Seismol. Soc. America, Bull., v. 49, no. 4, p. 337-347, map, 6 tables, Oct. 1959, 17 refs.; also pub. as: California Inst. Technology, Div. Geol. Sci., Contr. no. 926.

The large number of fault-plane solutions at present available in the literature permit one to calculate several statistical averages that have an important bearing upon geotectonics. The present paper represents a continuation of earlier work in this direction: 101 new fault-plane solutions are listed, and the ratio of pressure to tension, strike slip to dip slip, and the average slip angle have been calculated for 9 earthquake areas. Some of the older results are thereby corroborated, viz., that the "normal" character of earthquakes is to represent strike-slip faulting, and that the central Asian regions constitute an exception to this rule. In addition, it is now possible to make a breakdown with regard to depth. In this, a peculiar situation is found at 0.03 R depth, where the slip angle reaches a maximum. If the relationship between shallow and deep earthquakes be considered for any one area, however, it turns out that they are on the whole of the same character. Thus, whatever it is that causes earthquakes, acts in a similar fashion at all depths in any one area, but differs from one area to another.--Auth.

2-157. Milne, Allen R. COMPARISON OF SPECTRA OF AN EARTHQUAKE T-PHASE WITH SIMILAR SIGNALS FROM NUCLEAR EXPLOSIONS: Seismol. Soc. America, Bull., v. 49, no. 4, p. 317-329, 11 figs. incl. 2 charts, diags., graphs, Oct. 1959, 8 refs.

Hydrophones from a surface vessel in 1,300 fathoms of water off Juan de Fuca Strait detected, in the course of the "Hardtack" series of tests in the Marshall Islands, 3 acoustic signals which had peaks in their energy spectra at frequencies less than 20 c.p.s. Two of these appear to have originated from nuclear explosions; the third, though having a similar energy spectrum, was apparently a T-phase from an earthquake near Cape Mendocino with its epicenter at 40° 16'N., 124° 12'W., and an original time of 23:04:46 on May 24, 1958.

Travel-time measurements and signal spectra indicate that the nuclear explosions originated within Eniwetok Atoll. The coupling of their signals to the water path apparently was similar in nature to that of the earthquake T-phase, but the duration of the signals from the nuclear explosions was considerably less.--Auth.

2-158. Scheidegger, Adrian E. SEISMIC EVIDENCE FOR THE TECTONICS OF CENTRAL AND WESTERN ASIA: Seismol. Soc. America, Bull., v. 49, no. 4, p. 369-378, 5 maps, table, Oct. 1959, 11 refs.; also pub. as: California Inst. Technology, Div. Geol. Sci., Contr. no. 930.

A statistical analysis of the null axes of the fault-plane solutions of earthquakes in any one area permits determination of the average tectonic motion direction of that area. In the present paper this method has been applied to areas in central and western Asia for which several hundred fault-plane solutions are readily available in the literature. The investigation yields the result that (seismically) calculated tectonic motion directions in a series of small areas that are part of a larger unit are consistent with each other and that there is in every case an excellent correlation with the tectonic motion of the area as postulated from geological studies. This appears to justify completely the seismic method.

The seismically determined tectonic motion in central Asia appears to be mainly in a N.-S. direction. The motion refers to the present time (since the earthquakes occur at the present time), but it is the same as that postulated in geology for an explanation of the folding of the central Asian mountain ranges. This demonstrates that the stress system which created the central Asian mountains is active at the present time.--Auth.

2-159. DeNoyer, John. CRUSTAL STRUCTURE OF THE NORTH PACIFIC FROM LOVE-WAVE DISPERSION: Seismol. Soc. America, Bull., v. 49, no. 4, p. 331-336, 3 figs. incl. map, Oct. 1959, 5 refs.

Short-period Love wave dispersion from the Kurile Islands earthquake (June 22, 1952; O = $21^h\ 41^m\ 53^s$; $\phi = 46^o$ N.; $\lambda = 153^o.5$ E.) can be explained with a 2-layer crustal model in which the upper 2 km. of material has a shear-wave velocity of 2.31 km./sec. The second layer has a thickness of 4 km. and a shear-wave velocity of 3.71 to 3.86 km./sec. Shear-wave velocities of 4.50 to 4.52 km./sec. are used for the material immediately below the crust. This crustal model is compared with structures obtained from short-period Love wave dispersion across other Pacific paths and with results of refraction studies. --Auth.

2-160. Officer, Charles B. INTRODUCTION TO THE THEORY OF SOUND TRANSMISSION, WITH APPLICATION TO THE OCEANS: 284 p., charts, diags., graphs, New York, McGraw-Hill, 1958, refs.

Any acoustic problem consists of some sort of source, transmission, and reception; this book covers the second. It is at the senior undergraduate - first-year graduate course level. Specific applications of the theory have been given to a description of sound transmission in the ocean. Wherever possible, physical explanations are given of the theoretical results. The mathematics involved are carried through in some detail; those problems involving the evaluation of integrals have had the integrals reduced to a familiar or tabular form. --M. Russell

Contents:

2-161. Knopoff, Leon. THE SEISMIC PULSE IN MATERIALS POSSESSING SOLID FRICTION, II: LAMB'S PROBLEM: Seismol. Soc. America, Bull., v. 49, no. 4, p. 403-413, 5 figs., table, Oct. 1959, 10 refs.; also pub. as: California, Univ., (Los Angeles), Inst. Geophysics, Pub. no. 124.

The study of the propagation of seismic waves through a medium having attenuation factors varying as the first power of the frequency has been extended to the geometry used by Lamb for the perfectly elastic case. The results show 3 pulse groups corresponding to P. S, and R events. For high Q, all 3 pulses are very sharp; these pulses broaden at rates proportional to the product of the distance and 1/Q. For symmetric pulse input and high Q, the R pulse is noticeably asymmetric, the P pulse only weakly so.--Auth.

2-162. Berg, Joseph W., Jr., and Kenneth L. Cook. GROUND-MOTION MEASUREMENTS NEAR QUARRY BLASTS AT PROMONTORY POINT, UTAH: Seismol. Soc. America, Bull., v. 49, no. 4, p. 391-397, 4 figs. incl. map, graphs, table, Oct. 1959, 4 refs.

Ground amplitudes and accelerations are presented for distances of 8,000 ft., 22,000 ft., 43,700 ft., and 72,200 ft. from 3 quarry blasts of more than 1,000,000 lbs. of explosives each that were detonated at Promontory Point. The following equation fits the data of the maximum total displacement amplitude versus distance for the distances given above:

$$\log D_m = -1.52 \log X + 4.51,$$

where D_m is the maximum total displacement amplitude in inches, and X is distance in feet from the source. Maximum vertical acceleration versus distance for the same distances is given by the

equation:

$$\log A_m = -2.55 \log X + 10.68,$$

where A_m is the maximum vertical acceleration in ft./sec.^{2} and X is distance in feet from the source.--Auth.

2-163. Brune, James N., and Jack E. Oliver. THE SEISMIC NOISE OF THE EARTH'S SURFACE: Seismol. Soc. America, Bull., v. 49, no. 4, p. 349-353, graph, Oct. 1959, 29 refs.; also pub. as: Columbia Univ., Lamont Geol. Observatory, Contr. no. 368.

Maximum, average, and minimum values of surface particle displacement, velocity, and acceleration of earth noise as a function of period are illustrated in graphical form. For periods less than about 5 sec. the amplitude curves rise rapidly with increasing period. The most prominent feature of the illustration is the sharp peak in the 5- to 8-sec. period range. There are virtually no data on noise in the range of periods between 20 sec. and the earth tide periods. With the exception of the 10- to 40-sec. period range, the data used are taken from the existing literature. --Auth.

2-164. Takeuchi, H. A COMMENT ON THE FLATTENING OF THE GROUP VELOCITY CURVE OF MANTLE RAYLEIGH WAVES WITH PERIODS ABOUT 500 SEC.: Seismol. Soc. America, Bull., v. 49, no. 4, p. 365-368, 3 graphs, Oct. 1959, 11 refs.; also pub. as: California Inst. Technology, Div. Geol. Sci., Contr. no. 923.

A scale-ratio consideration and a calculation on statical deformations of the earth by surface loads suggest that the flattening of the group velocity curve of mantle Rayleigh waves with periods about 500 sec. is not due to the existence of the earth's core, as has been suggested.--Auth.

2-165. Takeuchi, H., Frank Press, and N. Kobayashi. RAYLEIGH-WAVE EVIDENCE FOR THE LOW-VELOCITY ZONE IN THE MANTLE: Seismol. Soc. America, Bull., v. 49, no. 4, p. 355-364, graph, 3 tables, Oct. 1959, 17 refs.; also pub as: California Inst. Technology, Div. Geol. Sci., Contr. no. 922.

Variational calculus methods are applied to the problem of dispersion of mantle Rayleigh waves. In the present paper we have worked 2 models. One is Gutenberg's model with a low-velocity layer around 150 km. depth. The other is a Jeffreys-Bullen model modified above 200 km. depth so as to join smoothly to the explosion-determined velocities just under the Mohorovičić discontinuity. No low-velocity layer is assumed in this model. Both models give almost identical theoretical dispersion curves which agree well with the Ewing-Press observations of mantle Rayleigh waves for periods longer than 250 sec. This result means that the minimum group velocity at about 250 sec. is mainly due to a sharp increase of shear velocity at about 400 km. depth, which is a common feature for the 2 models. For periods shorter than 250 sec. Gutenberg's model gives results concordant with the observations. The modified Jeffreys-Bullen model disagrees significantly with the observations. This demonstrates the existence of a low-velocity layer in the upper mantle. --Auth.

2-166. Oliver, Jack E., James Dorman, and George H. Sutton. THE SECOND SHEAR MODE OF CONTINENTAL RAYLEIGH WAVES: Seismol. Soc. America, Bull., v. 49, no. 4, p. 379-389, 6 figs. incl. graphs, table, Oct. 1959, 7 refs.; also pub. as: Columbia Univ., Lamont Geol. Observatory, Contr. no. 367.

Waves of the Rayleigh type corresponding to the fundamental and first shear modes for the continental crust-mantle system have been identified on seismograms previously. In this paper, waves corresponding to the second shear mode are identified for 2 paths, one from the Belgian Congo to Pietermaritzburg, South Africa; the other from Oklahoma to Palisades, New York. Comparison of the dispersion of these waves with theoretical dispersion for several crust-mantle models demonstrates the increase in resolving power of this method of obtaining crustal structure when data for several modes are available. There are small but measurable differences in the velocity structures averaged along these 2 paths.--Auth.

2-167. Byerly, P. Edward, and Henry R. Joesting. REGIONAL GEOPHYSICAL INVESTIGATIONS OF THE LISBON VALLEY AREA, UTAH AND COLORADO: U.S. Geol. Survey, Prof. Paper 316-C, p. 39-50, 7 maps (5 in pocket), 2 secs., 4 diags., 1959, 28 refs.

Aeromagnetic and gravity surveys have been conducted in the Lisbon Valley area as part of a study of the regional geology of the Colorado Plateau. The Lisbon Valley area is located in the Paradox basin in the E.-central part of the Colorado Plateau. As here defined it includes the southern three-quarters of the Mount Peale, Utah and Colorado, 30-min. quadrangle.

Exposed rocks range in age from Pennsylvanian to Quaternary, and include, in the northern part of the area, the intrusive rocks of the La Sal Mountains of probable Tertiary age. The Pennsylvanian section includes limestones and clastic rocks, whereas the overlying Permian and younger sedimentary rocks are mainly sandstone, siltstone, and shale. Evaporites of Pennsylvanian age have been penetrated in a well in the Lisbon Valley area. Older rocks of Pennsylvanian, Mississippian, Devonian, and Cambrian(?) age have been penetrated in wells drilled in adjoining areas, and probably are present in the Lisbon Valley area.

The major structure is the Lisbon Valley faulted salt anticline, with its accompanying negative gravity anomaly of about 15 mgals. This structure differs from most of the other large salt anticlines of the Paradox basin, in that the evaporites do not intrude the overlying rocks. A piercement salt plug, N. of the Lisbon Valley anticline, and local thickening of salt in the western and northwestern parts of the area are also indicated by gravity anomalies. The alignment of late Paleozoic salt intrusions with the South Mountain group of igneous intrusions in the La Sal Mountains indicates that this group was intruded along a zone of previous structural activity.

The magnetic anomalies are caused mainly by variations in the magnetization of the basement rocks. Basement structural trends, as indicated by magnetic trends, coincide in part with surface structure and are divergent in part. A prominent basement ridge or platform in the southwestern part of the area, flanked by a basin to the NE., is indicated by the magnetic data.--Auth.

7. GEOCHEMISTRY

See also: Mineral Deposits 2-198; Fuels 2-211 through 2-232.

2-168. Flinn, Derek. **AN APPLICATION OF STATISTICAL ANALYSIS TO PETROCHEMICAL DATA: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 161-175, 5 tables, Nov. 1959, 11 refs.**

The development of rapid methods of silicate analysis has made possible the study of chemical variation in rock masses by means of large numbers of analyses. To obtain the maximum benefit from the data in the form of conclusions of stated probability of correctness and numerical estimates of variation and of differences, statistical methods have to be employed. In a recent paper Pitcher and Sinha publish about 50 rock analyses from the neighborhood of the Ardara pluton, Donegal, Eire. In the present paper these data are statistically analysed. Several statistical methods are employed, i. e. t-test, one-way and two-way analysis of variance. Each is related to the sampling scheme that it requires and the questions it can answer. Pitcher and Sinha's conclusions are reproduced statistically and given, together with numerical estimates of the probability of their correctness and of the compositional differences they discovered. Further conclusions are also drawn. Consideration of the problem tackled by Pitcher and Sinha and of their data shows that possibly a three-way partially nested analysis of variance is the experimental design best suited to their purpose, but their sampling scheme is not amenable to this form of analysis.--Auth.

2-169. Grace, J.D., and Thomas F. Bates. **DETERMINATION OF URANIUM EQUILIBRIUM IN ROCKS USING α AND FISSION FRAGMENT RADIOGRAPHY: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 226-233, graph, table, Nov. 1959, 10 refs.**

A technique has been developed that permits the determination of U-daughter product equilibrium in polished sections by combining α and fission fragment radiography. The procedure consists of placing an uncovered rock section in contact with, first, an α-sensitive emulsion to record the α-particle emission from U and its 8 α-emitting daughter products, and second, an emulsion sensitive to fission fragments (but not α-particles) to record the tracks of fission fragments produced from U^{235} when the slide is bombarded with thermal neutrons. A sample with approximately 100 p. p. m. of U in equilibrium emits about 570 α-tracks/$cm.^2$ per day in an autoradiograph, and about 10,000 fission fragment tracks/$cm.^2$ per hour when exposed to a neutron flux of 2·25 x 10^{10} neutrons/$cm.^2$ per sec. A sample deficient in U daughter products will release relatively more fission fragment tracks than α-tracks, and the opposite is true if the sample has a deficiency of U with respect to daughter products.

The technique has the advantages of being non-destructive, applicable on a micro scale, and suitable for use on samples having U contents as low as 10 p. p. m.--Auth.

2-170. Kazakov, A.V., M.M. Tikhomirova, and V.I. Plotnikova. **THE SYSTEM OF CARBONATE EQUILIBRIA. Translated by V.P. Sokoloff: Internat. Geology Rev., v. 1, no. 10, p. 1-39, 16 figs. incl. illus., diags., graphs, 23 tables, Oct. 1959, 91 refs.**

The occurrence of dolomites with phosphorites in geosynclinal areas of the U. S. S. R., the wide distribution of dolomitic sediments in the Paleozoic and their absence in the Jurassic and Cretaceous of the Russian platform, and the absence of dolomite formation in modern marine sediments have led to the study of their origin. The possibility of a simultaneous (synchronous) development of phosphorites and dolomites (magnesites) is excluded. Concurrence is explained by subsequent impositions of diagenetic and epigenetic dolomites on previously deposited phosphate. Primary dolomites are negative prospecting indicators for phosphorites; secondary dolomites are not. Analysis of magnesite and dolomite systems at the 20°, 60°, and 150°C. isotherms is offered in the experimental part of this report. Fields of crystallization and stability are defined for nesquehonite, magnesite, dolomite, basic magnesium carbonate (artinite and hydromagnesite), and brucite systems.--G. E. Denegar.

2-171. Weyl, Peter K. **THE CHANGE IN SOLUBILITY OF CALCIUM CARBONATE WITH TEMPERATURE AND CARBON DIOXIDE CONTENT: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 214-225, 2 diags., 7 graphs, 2 tables, Nov. 1959, 7 refs.**

The solubility of calcite and aragonite in carbonic acid has been determined over a CO_2 concentration range from 10^{-4} to 10^{-3} molal and a temperature range from 10° to 70°C. The measurements were made in the absence of a gas phase in a newly developed conductometric solubility apparatus. The temperature derivative of solubility of calcite at constant CO_2 concentration varies from -10^{-6} to -3×10^{-5} molal/°C., being a maximum for the highest CO_2 concentration and temperature. The derivative of the solubility of calcite with respect to CO_2 concentration at constant temperature has a value approximately 1 at very low CO_2 concentrations and decreases as the CO_2 concentration rises.

At low CO_2 concentrations, the solubility of aragonite is the same as that of calcite within the experimental errors. At a CO_2 concentration of 10^{-3} molal, aragonite is about 11% more soluble than calcite. --Auth.

2-172. Paneth, F.A. **DER METEORIT VON BREITSCHEID - I. EINLEITUNG [THE BREITSCHEID METERORITE - I. INTRODUCTION]: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 315-319, Nov. 1959; text in German, abstracts in English and German.**

On Aug. 11, 1956 a stone meteorite fell at Breitscheid in the Dillkreis (50°51'N. 8°12'E.) [Germany] the weight of which was supposed to about 1·5 kg. But before recognition of its meteoritic character the stone was broken to pieces so that the total weight of the fragments amounted only to 970 g. The petrographic examination showed in thin sections a multiplicity of most characteristic chondrules; the Breitscheid meteorite is a bronzite-olivine-chondrite. It is remarkable that troilite was found in primary as well as in secondary formation and that ilmenite could be proved to be a meteoritic mineral. The total chemical analysis corresponds very well with the petrographic results.

He, Ne, Ar, tritium, K, and U were measured by special methods which partly had to be developed only during the course of work. Furthermore, it was found that the isotopic composition of He and Ne greatly differs from that of the corresponding terrestrial gases. A geological age of 3300 million years results from the Ar/K ratio. The content of

He and Ne differs widely in various parts of the meteorite, a phenomena which has to be explained in detail. An irradiation age of about 20 million years for the Breitscheid meteorite would result from the ratio He-3 to tritium in one part of the meteorite.--Auth.

2-173. Vilcsek, Else. DER METEORIT VON BREITSCHEID - II. CHEMISCHE ANALYSE [THE BREITSCHEID METEORITE - II. CHEMICAL ANALYSIS]: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 320-322, Nov. 1959, 5 refs.; text in German.

2-174. Hentschel, H. DER METEORIT VON BREITSCHEID - III. PETROGRAPHISCHE UNTERSUCHUNG [THE BREITSCHEID METEORITE - III. PETROGRAPHIC ANALYSIS]: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 323-338, 18 illus., 3 tables, Nov. 1959, 10 refs.; text in German, abstracts in English and German.

The meteorite of Breitscheid is a gray-veined bronzite-olivine-chondrite containing Ni-Fe and troilite. It has a remarkably high volume of pores of about 10%. The density of the solid is 3.7, of the stone as a whole 3.3. The chondrules take about 20% of the volume of the stone. The ore minerals are: Ni-Fe (kamacite and taenite), troilite, chromite, ilmenite, and, in the melting crust, magnetite. Ilmenite especially - until recently doubtful as a constituent of meteorites - could be proved in a convincing manner. The silicate constituents are: olivine, bronzite, clinopyroxene, plagioclase (?), glass, and a few minerals which could not be identified.

The mineral composition and the fabric are described. In addition, the mineral composition, calculated by chemical analysis, is given. It is remarkable that troilite appears in 2 varieties, one of which evidently is secondary, because it is always embedded in Ni-Fe in a metasomatic manner.--Auth.

2-175. DER METEORIT VON BREITSCHEID - IV. RADIOCHEMISCHE UNTERSUCHUNGEN [THE BREITSCHEID METEORITE - IV. RADIOCHEMICAL ANALYSIS]: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 339-351, 2 tables, Nov. 1959, 36 refs.; text in German.

In 4 parts:

König, H., H. Wänke, and K.I. Mayne. Helium und Neon [Helium and Neon], p. 339-342, 17 refs.

Goebel, K., and P. Schmidlin. Tritium, p. 342-349, 14 refs.

Ebert, K.H., F. Hernegger, H. König, and H. Wänke. Uran [Uranium], p. 349-350, 4 refs.

König, H., and H. Wänke. Kalium-Argon [Potassium-Argon], p. 350-351, ref.

2-176. Cherry, R.D., and S.R. Taylor. ORIGIN OF Be^{10} AND Al^{26} IN TEKTITES: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 176-185, 2 graphs, 2 tables, Nov. 1959, 37 refs.

An attempt is made to show that the recently reported amounts of Be^{10} and Al^{26} in tektites can possibly be explained in terms of Urey's "comet" hypothesis for tektite origin. On the basis of our calculations we obtain a similar level of Be^{10} activity to that reported by Ehmann and Kohman, but a somewhat lower figure for Al^{26} activity.

It is shown that by mixing one part of chondritic silicate, which is assumed to represent the non-volatile comet material and to contain the radioactive nuclides, with 13 parts of arkoselike material, the over-all tektite composition can be accounted for rather satisfactorarily.--Auth.

2-177. Senftle, Frank E., and A. Thorpe. MAGNETIC SUSCEPTIBILITY OF TEKTITES AND SOME OTHER GLASSES: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 234-247, 3 illus., graph, 4 tables, Nov. 1959, 19 refs.

The magnetic susceptibility at several magnetic field strengths of about 30 tektites from various localities have been measured. The susceptibility ranges from 2×10^{-6} to about 7.9×10^{-6} e.m.u./g. Tektites from a given locality have similar susceptibilities. The intensity of magnetization of all the tektites measured is zero or very small.

For comparison, the same measurements have been made on about 30 obsidians. The magnetic susceptibilities cover approximately the same range, but the intensity of magnetization of the impurity was found to be much higher. By heating the obsidians to 1450°C. the intensity of magnetization was reduced to zero.

From the above data, it is shown that the tektites must have been heated well above 1400°C. and that essentially all the Fe is in solution. On the other hand, the evidence shows that obsidians have not been heated much above this temperature and that there is a significant amount of undissolved Fe in the glass, probably as magnetite. Further, if tektites are extraterrestrial, they probably entered the earth's atmosphere as a glass.--Auth.

2-178. Whitfield, J.M., John J.W. Rogers, and J.A.S. Adams. THE RELATIONSHIP BETWEEN THE PETROLOGY AND THE THORIUM AND URANIUM CONTENTS OF SOME GRANITIC ROCKS: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 248-271, 13 graphs, 4 tables, Nov. 1959, 34 refs.

Th and U contents of granitic rocks are intimately related to modal compositions and general petrologic features. Correlations are quite distinct between Th content and common indices of general petrogenetic evolution, such as amount of dark minerals, percentage of anorthite in plagioclase, and ratio of K feldspar to plagioclase. Th content increases regularly toward the more acidic rocks, and the increase is most pronounced in the most highly alkali samples. U content generally shows little, if any, relationship to modal composition or other petrologic features, and the increase in abundance of U toward the more acidic rocks is irregular.

The greater petrogenetic control of Th than of U content may be explained on the basis of oxidation and repeated loss of U from magmas during the later stages of their differentiation. Such an explanation assumes that magmas are originally derived from a relatively homogeneous source; remobilization, however, of different types of sedimentary or other rocks might provide granitic magmas of widely different initial Th and U contents. The possibility that Th is added hydrothermally to granites is partly supported by unusually high abundance of Th in some red, porphyritic, allanite-bearing rocks, but the general petrologic control of Th abundances argues against major secondary addition of material.--Auth.

2-179. Whitfield, J.M., John J.W. Rogers, and M.C. McEwen. RELATIONSHIPS AMONG TEXTUR-

PROPERTIES AND MODAL COMPOSITIONS OF ME GRANITIC ROCKS: Geochim. et Cosmochim. ta, v. 17, no. 3/4, p. 272-285, 10 graphs, table, v. 1959, 6 refs.

Plots of modal percentages of mineral pairs in anitic rocks show negative correlation between abundance of K feldspar and the abundances of gioclase and biotite, and the percentage anorte in plagioclase. A positive correlation is found tween plagioclase and biotite, plagioclase and rcentage anorthite in plagioclase, and biotite and rcentage anorthite in plagioclase. The distribution quartz is erratic as shown by the absence of rrelation between quartz and other mineral abunnces.

Study of modal compositions of groups of granitic cks subdivided on the basis of various textural operties leads to characterization of granitic rocks terms of 2 ideal "end members." One type of anite consists of subhedral zoned plagioclase laths th interstitial quartz and K feldspar; abundances plagioclase, biotite, and hornblende are comparvely high in this type, whereas K feldspar is arce. The other end member granite contains ughly equal amounts of quartz, K feldspar, and agioclase, with minor biotite; all minerals are hedral, and the plagioclase is twinned and unzoned. mplete gradation exists between these 2 types of anite.

The complete gradation between the 2 granitic xtural and compositional types indicates that most anites have evolved by one general process. In ew of the definite correlations, both positive and gative, among the abundances of K feldspar, agioclase, biotite, and percentage anorthite in agioclase, it is proposed that this process is one magmatic differentiation. The relationships can explained by differentiation but would appear rtuitous if metasomatism were a major factor.--uth.

180. Heier, K.S., and S.R. Taylor. DISTRIBUON OF Ca, Sr AND Ba IN SOUTHERN NORWEGIAN RE-CAMBRIAN ALKALI FELDSPARS: Geochim. Cosmochim. Acta, v. 17, no. 3/4, p. 286-304, figs. incl. graphs, diags., 6 tables, Nov. 1959, refs.

Ca, Sr, and Ba have been determined spectroemically in alkali feldspars from gneisses, gengneisses, anatexe granites, diapir granites, d small and large pegmatites from the Precambrian sement rocks of southern Norway. Ca decreases feldspars from large pegmatites, but not to the me extent as Sr and Ba. It is shown that Sr readily bstitutes in K feldspar. A close association of and Sr was found. With increasing fractionation e Ba/Sr ratio decreases and is lowest in the large gmatites, as are the absolute amounts of Sr and . The behavior of Ca, Sr, and Ba is explained ainly by the relative bond strengths; Ba which forms e bond with most ionic character is preferentially cepted.--Auth.

181. Pettersson, Hans. MANGANESE AND NICKL ON THE OCEAN FLOOR: Geochim. et Cosmoim. Acta, v. 17, no. 3/4, p. 209-213, 4 figs., v. 1959, 16 refs.

The writer finds no reason to abandon his earlier blished view, that the origin of the 2 elements here scussed in the deep-sea sediments is different om that of the other ferrides, especially as regards the anomalously high values for Mn and Ni contents, the former being largely due to suboceanic volcanic action, the latter due to contributions from the cosmos.--Auth. concl.

2-182. Tatsumoto, Mitsunobu, and Edward D. Goldberg. SOME ASPECTS OF THE MARINE GEOCHEMISTRY OF URANIUM: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 201-208, graph, 5 tables, Nov. 1959, 10 refs.

The U concentrations in marine calcareous material of a biological origin varied between 0·0X and 0·X p.p.m., with the exception of corals which had concentrations of several p.p.m. The aragonitic oölites and aragonite precipitated from sea water had values similar to those of the corals. A geochronology based on the growth of ionium (Th-230) from U is applicable not only to corals, as previous investigators have pointed out, but also to oölites. Several examples of "oölite ages" are given. The U content of ferromanganese minerals from pelagic deposits is of the order of from 4 to 5 p.p.m.--Auth.

2-183. Mohr, P.A. A GEOCHEMICAL STUDY OF THE SHALES OF THE LOWER CAMBRIAN MANGANESE SHALE GROUP OF THE HARLECH DOME, NORTH WALES: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 186-200, 6 tables, Nov. 1959, 21 refs.

The shales of the Manganese Shale group are featured geochemically by their relatively high Mn content, the predominance of ferrous over ferric Fe, the sympathetic behavior of Co, Ni, Cr, and V with total Fe, an inverse relationship of Sr and Ba and a direct relationship of B and Ba. Evidence is presented to indicate that the source rocks of the Manganese Shales were acid gneisses.--Auth.

2-184. Hem, John D., and William H. Cropper. SURVEY OF FERROUS-FERRIC CHEMICAL EQUILIBRIA AND REDOX POTENTIALS: U.S. Geol. Survey, Water-Supply Paper 1459-A, 30 p., diag., graph, 11 tables, 1959, 20 refs.

Amounts of Fe in solution in natural water at equilibrium are related to the pH and Eh of the solution. Important ionic species present include Fe^{+++}, $FeOH^{++}$, $Fe(OH)^{+}_2$, Fe^{++}, and $FeOH^{+}$. A stability field diagram shows the Eh and pH values at which each of these predominates. $Fe(OH)_3$(aq) may be present as part of the dissolved Fe in natural water at alkaline pH, and Fe $(OH)_2$(aq) may exist at pH 10 and above. The total solubility of Fe at pH levels from 4 to 9 is shown graphically by 7 curves for Eh values from −0. 10 to + 0. 50. The amounts of Fe that theoretically could be present in solution are mostly below 0. 01 p.p.m. if pH is between 5 and 8 and Eh between 0. 30 and 0. 50. The content of Fe^{++} could exceed 100 p.p.m., however, at pH 5 and eH 0. 30.

Solutions containing 12 to 24 p.p.m. of Fe in various proportions of Fe^{++} to Fe^{+++} were unstable when exposed to air. Changes in the Eh values of these solutions, measured with the Pt and calomel electrodes, indicate that equilibrium is not reached in such mixtures at the end of a week when the initial pH is 3. 6 to 4. 1.

A natural ground water containing 16 p.p.m. of ferrous Fe when collected, and 9 artificial solutions containing from about 12 to about 26 p.p.m. of ferrous Fe at pH 5. 8 to 6. 7, lost Fe by oxidation

and precipitation of ferric hydroxide at a rate governed by the diffusion of O through water. An aliquot of the natural water, acidified to pH 1.6, lost no ferrous Fe after 3 months.

If equilibrium is assumed in ground water in its natural environment, determinations of pH in the field and of Fe concentration in samples of the water form a basis for computing the Eh within aquifers where this property cannot be measured directly.

In aerated waters whose pH is above about 5, ferric Fe can be present in excess of 0.01 p.p.m. only as a suspension of oxide or hydroxide. The particles may be of colloidal size or larger. Complexing effects of chloride and fluoride are important in strongly acid solutions of ferric Fe but they do not seem to have much effect on the behavior of Fe in waters in the range of pH 5 to 8. Organic complexing effects were not studied.--Auth.

2-185. Ichikuni, M. TENEURS EN CUIVRE ET EN ZINC DES EAUX THERMALES AU JAPON [DISTRIBUTION OF COPPER AND ZINC IN THERMAL WATERS OF JAPAN]: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 305-314, graphs, 4 tables, Nov. 1959, 16 refs.; text in French, abstracts in English and French.

Lognormality of the distribution of Cu and Zn in thermal waters is shown. The pH plays an important role in the distribution of Zn. The concentration of Zn is higher in waters of pH below 5 than in those of pH above 5. The Cu content, however, is not influenced by the pH. The distribution of Cu is controlled probably by the oxidation-reduction potential.--Auth.

2-186. Gottfried, David, Howard W. Jaffe, and Frank E. Senftle. EVALUATION OF THE LEAD-ALPHA (LARSEN) METHOD FOR DETERMINING AGES OF IGNEOUS ROCKS: U.S. Geol. Survey, Bull. 1097-A, 63 p., 3 illus., 6 graphs, 22 tables, 1959, 97 refs.

The age of an igneous rock can be determined from the Pb-alpha activity ratios of certain accessory minerals (zircon, monazite, xenotime, and thorite) provided that, 1) these minerals crystallized contemporaneously with the enclosing rock-forming minerals, 2) their Pb is all of radiogenic origin formed by decay of U and Th after formation of these minerals, and 3) they have neither lost nor gained parent or daughter products since the time of crystallization.

The largest single source of analytical error is in the Pb analysis, particularly for minerals which contain less than 10 p.p.m. of Pb. For zircon and other accessory minerals that contain more than 10 p.p.m. of Pb the analytical precision is 4 to 10% of the mean of duplicate measurements. Comparisons between the alpha emission measured by thick source alpha counting and that calculated from quantitative determinations of the U and Th content of zircon and monazite indicate that the alpha activity measurements have an accuracy of $\pm$ 5%.

Where the method has been applied to a large number of samples of suites of igneous rocks younger than Precambrian, the scatter pattern of the age data is what would be expected from the experimental errors. In general, the standard deviation from the mean age is about 10% or less for minerals from suites of rocks older than Cretaceous. For younger rocks, which contain zircon with very low Pb content, the standard deviation from the mean is considerably greater than 10% but is less than 10 million years. Inasmuch as zircon, monazite, and xenotime from the same rocks give ages which agree within limits of error of the method, it seems that the presence of common Pb or the loss or gain of parent or daughter products do not contribute significantly to the errors in the age measurements of most of the rocks tested that were younger than Precambrian. Age determinations have been made on many geologically well dated rocks in order to test the validity of the method by use of geologic evidence. With few exceptions, the age data agree with the geologic sequence of events and with the Holmes' B geologic time scale.

Pb-alpha ages are in good agreement with many of the ages determined by the Pb isotope, Ar^{40}: K^{40}, and Sr^{87}: Rb^{87} methods on minerals from unmetamorphosed igneous rocks younger than Precambrian. However, the agreement with other methods is poor for zircon from Precambrian rocks inasmuch as the Pb-alpha age corresponds to the Pb^{206}: U^{238} age which is commonly lower than the Pb^{207}: Pb^{206} age and concordant Ar^{40}: K^{40} and Sr^{87}: Rb^{87} age on mica. When concordant Pb isotope ages are obtained on Precambrian zircon, the Pb-alpha age will also agree within the limits of error of the method.

As yet no satisfactory explanation has been found for the wide discrepancies in the measured ages of Precambrian zircon, but it seems likely that Pb has been lost by partial or complete recrystallization in response to metamorphic processes. Pb-alpha ages determined on metamorphosed igneous rocks will generally not correspond to the true age of igneous activity, but may approach the age of metamorphism.--Auth.

2-187. Broecker, Wallace S., and E.Z. Olson C-14 DATING OF CAVE FORMATIONS: Natl. Speleol. Soc., Bull., v. 21, pt. 1, p. 43, Jan. 1959.

Recent studies of calcium carbonate deposition in caves indicate that C-14 dating may be applicable to dating of cave formations. CO_2 in solution, derived from surface materials, interacting to dissolve limestone or the possibility that some $CaCO_3$ deposited in the formation may be derived from material in the near surface ground-water system would form the basis of dating. Accuracy of 2,000 years in 30,000 may be possible.--Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Mineral Deposits 2-197, 2-206.

2-188. Jong, W.F. de, with the collaboration of J. Bouman. GENERAL CRYSTALLOGRAPHY: A BRIEF COMPENDIUM: 281 p., 231 figs., 41 tables, San Francisco, W.H. Freeman, 1959, refs..

The first compendium of crystallography was printed in the Dutch language in 1951. This American version contains several additions and revisions. Although not designed as a textbook, it may be used as a guide for private study. "In its present form, with its emphasis on the role of symmetry... the book

will serve undergraduate students as a summary of the modern view of crystallography."--From auth. pref.

Contents:

2-189. Pallister, Hugh D., Earl L. Hastings, Thomas W. Daniel, Jr., and C.W. Bozeman. THE FORMATION OF PYRITE, MARCASITE AND OTHER SULPHIDES IN RECENT OR LATE GEOLOGIC TIME: Alabama Acad. Sci., Jour., v. 30, no. 4, p. 24-26, Apr. 1959, 2 refs.

Pyrite and marcasite have been found in masses and crystals in the coastal plain area of Alabama. It has sometimes been difficult to tell them apart from crystal structure alone. According to Clark, pyrite tends to form at slightly hotter temperatures than marcasite, and marcasite has been known to be transformed into pyrite at 450°. Several deposits of marcasite and pyrite in Alabama are described. It is concluded that the Fe and S were carried in a ferric or ferrous sulfate solution. Hydrogen sulfide, formed by contact of this solution with decaying vegetable matter, could have then reacted with the solution to bring about the deposition of iron sulfide. Under normal temperatures, marcasite would have formed; under slightly higher temperatures pyrite might have been deposited instead of marcasite.--L.M. Dane.

9. IGNEOUS AND METAMORPHIC PETROLOGY

See also: Structural Geology 2-77, 2-80; Geochemistry 2-168, 2-178, 2-179, 2-180.

2-190. Wilson, Ben Hur. ALONG THE EARTHQUAKE BELT. Earth Sci., v. 12, no. 5, p. 157-160, 4 illus., Oct. 1959.

A record of historical earthquakes and eruptions of North American volcanoes is given, with photographs of the 1915 eruption of Mt. Lassen. The relationship between earthquake belts, volcanic zones, and basalt plateaus is explained.--M. Russell.

2-191. Drever, Harald I. GEOLOGICAL RESULTS OF FOUR EXPEDITIONS TO UBEKENDT EJLAND, WEST GREENLAND: Arctic, v. 11, no. 4, p. 198-210, 6 illus., map, 1958, pub. 1959, 14 refs.

Brief report of the author's research, both completed and in prospect, on the Tertiary extrusive and intrusive rocks of this island. Illustrating the text are 3 aerial photographs, 3 other field photographs and a geological map. Attention is focused mainly on the picritic lavas and minor intrusions, which, it is asserted, are developed to a greater degree than anywhere else. This view is substantiated by descriptive detail, by the illustrations, and by listed references to the author's comparative work on the Scottish picritic rocks. The paper embodies new field data and some amendments of his earlier publications. The extent and scientific status of the investigated research field is outlined and briefly discussed. It is established that magnesia-, lime-, and water-rich basic magmas were erupted or intruded on a major scale and that the island offers the finest prospect for investigating such magmas. A very substantial development in vesicular bands of calcic zeolites in the picritic lavas is very tentatively correlated with the anorthositic facies of basic plutons. Brief allusion is made to composite intrusion, in association with a layered gabbro - granite complex in the S. of contemporaneous basic and acid magmas.--Auth.

11. GEOHYDROLOGY

See also: Geochemistry 2-184.

2-192. Prescott, Glenn C., Jr. A PRELIMINARY SUMMARY OF GROUND-WATER CONDITIONS IN MAINE, 1958-59: U.S. Geol. Survey, Repts., Open-File Ser., 22 p., map, Aug. 1959, approx. 12 refs.

The principal sources of ground water in Maine are the glacial outwash deposits and the bedrock formations. Ground water in large quantities - enough for municipal and large-scale industrial use - is obtained chiefly from sand and gravel in the outwash. These deposits occupy many valleys and lowlands throughout the state and are especially widespread in the coastal lowlands and central uplands. Their specific location and water-bearing potentialities are generally unknown. Moderate to large amounts of water also are available locally from carbonate bedrock formations - limestone, marble, and calcareous slate and shale. These formations underlie most of the Aroostook Valley and the northern part of the Moosehead plateau. Ground water in small amounts - commonly enough for ordinary household and rural use - may be obtained from the bedrock formations at most places throughout the state. Less commonly, enough water may be obtained from these formations for small public supplies and small-scale industrial use.

Ground water in Maine is generally of good chemical quality. There are, however, some quality-of-water problems. Of these, excessive Fe and hardness are the more common. Excessive Fe occurs in ground water in scattered localities throughout the state. Excessive hardness is associated with the carbonate bedrock formations, princi-

pally in the Aroostook Valley and the northern part of the Moosehead plateau. Other quality-of-water problems, which are generally local in nature, include excessive concentrations of nitrate and chloride, brackishness, and high radioactivity.

There is a continuing trend toward larger withdrawals of ground water for municipal and industrial use and a growing demand for larger, more adequate supplies of water for the individual rural home and farm.

No modern interpretive reports on the ground-water resources of Maine have been prepared. A few early reconnaissance reports, long out of print, cover parts of the coastal lowlands and the central uplands.

A moderate amount of miscellaneous information is available, including published and unpublished geologic maps and reports, soils maps, data on wells and borings, data on water use, and chemical analyses. When assembled this information will be of appreciable value in interpreting the ground-water conditions. Topographic maps, adequate for the purpose of ground-water investigations, are available for most of the state.

The current ground-water investigation has uncovered no immediate critical ground-water problems of appreciable magnitude. Rather, it has confirmed the lack of basic information which is essential to the wise use and orderly development of the ground-water resources in Maine. Also, it has furnished a background for the planning of a long-range program oriented toward providing the information needed in the order in which it will be most useful. This program will be outlined in a separate report.--Auth. summ.

2-193. Pennsylvania, Bureau of Industrial Development. INDUSTRIAL WATER SUPPLIES IN PENNSYLVANIA: Its: Plant Location Factors Rept. no. 3, 88 p., 15 maps, 4 tables, Apr. 1958, 50 refs.

"This report, one of a series on plant location factors, presents in summary form Pennsylvania's basic water data most commonly used by industries in evaluating areas for plant locations."--From introd.

Contents: Availability of water in Pennsylvania - climate and availability, drainage pattern; basic water data - relative adequacy of data, climatological data, stream flow records, ground water data, quality of water data, miscellaneous studies; water use in Pennsylvania; water resources by drainage basins - Delaware River basin, Susquehanna River basin, Potomac River basin, upper Ohio River basin, Beaver River basin, Lake Erie basin, Genesee River basin, Chesapeake Bay basin; ground water. Appendix: range of pH and water hardness values of Pennsylvania streams at key sampling stations - range of pH values, annual range of pH values, water hardness values not exceeded 90% and 99% of the time.

2-194. Bjorklund, Louis J. GEOLOGY AND GROUND-WATER RESOURCES OF THE UPPER LODGEPOLE CREEK DRAINAGE BASIN, WYOMING. With a Section on Chemical Quality of the Water by R. A. Krieger and E. R. Jochens: U. S. Geol. Survey, Water-Supply Paper 1483, 40 p., 3 maps (2 in pocket, scale approx. 1 in. to 2 mi.), diag., 5 tables, 1959, 24 refs.

The principal sources of ground-water supply in the upper Lodgepole Creek drainage basin - the part of the basin W. of the Wyoming-Nebraska state line - are the Brule formation of Oligocene age, the Arikaree formation of Miocene age, the Ogallala formation of Pliocene age, and the unconsolidated deposits of Quaternary age.

The Brule formation is a moderately hard siltstone that generally is not a good aquifer. However, where it is fractured or where the upper part consists of pebbles of reworked siltstone, it will yield large quantities of water to wells. Many wells in the Pine Bluffs lowland, at the E. end of the area, derive water from the Brule. The Arikaree formation, which consists of loosely to moderately cemented fine sand, will yield small quantities of water to wells but is not thick enough or permeable enough to supply sufficient water for irrigation. Only a few wells derive water from it. The Ogallala formation consists of lenticular beds of clay, silt, sand, and gravel which, in part, are cemented with calcium carbonate. Only the lower part of the formation is saturated. Nearly all the wells in the upland part of the area tap the Ogallala, but they supply water in amounts sufficient for domestic and stock use only. Two of the wells have a moderately large discharge, and other wells of comparable discharge probably could be drilled in those parts of the upland where the saturated part of the Ogallala is fairly thick. Most of the unconsolidated deposits of Quaternary age are very permeable and, where a sufficient thickness is saturated, will yield large quantities of water to wells. These deposits are a significant source of water supply in the southeastern part of the area.

The Chadron formation of Oligocene age, which underlies the Brule formation, is a medium- to coarse-grained sandstone where it crops out in the Islay lowland. No wells tap the Chadron, but it probably would yield small quantities of water to wells. It lies at a relatively shallow depth beneath most of the Islay lowland, near the W. end of the area, and at a depth of about 300 ft. beneath the Pine Bluffs lowland. In the latter area it probably is finer grained and may not be permeable enough to yield water to wells.

All the ground water in the area is derived from precipitation. It is estimated that about 5% of the precipitation infiltrates directly to the zone of saturation. The remainder either is evaporated immediately; is retained by the soil, later to be evaporated or transpired; or is discharged by overland flow to the surface drainage courses. Most of the water that reaches the surface drainage courses eventually sinks to the zone of saturation or is evaporated. The slope of the water table and the movement of ground water are generally eastward. The depth to water ranges from less than 10 ft. in parts of the valley to about 300 ft. in the upland areas. In much of the Pine Bluffs lowland, the depth to water is less than 50 ft. Ground water not pumped from wells within the area is discharged by evapotranspiration where the water table is close to the land surface, by outflow into streams, or by underflow eastward beneath the state line.

The chemical quality of ground water from the principal sources is remarkably uniform, and the range in concentration of dissolved constituents is narrow. In general, the water is of the calcium bicarbonate type, is hard (hardness as $CaCO_3$ is as high as 246 p.p.m.), and contains less than about 400 p.p.m. of dissolved solids, which is a moderate mineralization. Silica constitutes a large proportion of the dissolved solids.

The water is suitable for irrigation and, except for Fe in water from some wells that tap the Ogallala formation, meets the drinking water standards of the

S. Public Health Service for chemical constituents. cause the water is siliceous, alkaline, and hard, it is unsuitable for many industrial uses unless treated.--Auth.

12. MINERAL DEPOSITS

e also: Geologic Maps 2-12, 2-13; Areal and Regional ology 2-37, 2-46, 2-48; Stratigraphy 2-91; Geophys-s 2-139, 2-144, 2-148 through 2-151.

195. Pallister, Hugh D. OUR MINERAL RE-URCES: A DISCUSSION OF NON-REPLACEABLE ESOURCES: Alabama Acad. Sci., Jour., v. 30, . 4, p. 5-8, Apr. 1959.

The supply of nonreplaceable mineral resources Alabama and the United States is briefly discussed. ne need of substitutes for such mineral resources - es and especially supplies of fresh water - is ressed.--L. M. Dane.

196. Little, H.W. TUNGSTEN DEPOSITS OF ANADA: Canada, Geol. Survey, Econ. Geology r. no. 17, 251 p., 29 maps (10 in pocket), 6 secs. in pocket), graph, 1959, approx. 275 refs.

W is a brilliant, white metal with many remark-ble properties. Its melting point of 3,370°C. and iling point of 5,900°C. are higher than those of y other metal. It has a low volatility. Its tensile rength of 590,000 lb. per sq. in. is likewise the eatest for all metals. The metal and its alloys e indispensable for certain purposes. Ferrous loys account for 60 to 90% of total W production, d most of these are high-speed steels in cutting ols. In all cases these alloys are characterized hardness and toughness, even at red heat. W rbide and nonferrous alloys are also used for tting tools because of their great hardness. etallic W, though used only in relatively minor antity in electrical apparatus in contact points, dio tubes, and filaments of electric lamps, is rtually irreplaceable.

The following 4 minerals are the principal sources W: ferberite, $FeWO_4$; hübnerite, $MnWO_4$; wolf-mite, $(Fe, Mn)WO_4$; and scheelite, $CaWO_4$.

Types of deposits that appear to be probable urces of W in Canada are as follows: 1) Alluvial lacer) deposits. These are known to occur in the ariboo and Atlin districts of British Columbia and e Yukon Territory. 2) Eluvial (residual) deposits. ne such deposit is known near the head of Dublin ulch, Yukon Territory. 3) Pegmatites. W-bearing gmatites occur in Nova Scotia, Manitoba, and ukon Territory. 4) Contact metamorphic deposits. ne largest W deposit known in Canada is of this pe and is near Salmo, British Columbia. Others cur elsewhere in southern British Columbia and Yukon Territory. 5) Quartz veins. W is common quartz veins throughout the Canadian Shield, the aritime Provinces, and the Cordillera, commonly an accessory in Au-bearing veins.--H. M. A. Rice.

Tungsten deposits in Europe, Asia, Australasia, frica, South America, and North America are also oted, and statistics of production are given.

-197. Ramdohr, Paul. THE MANGANESE ORES. ranslated by W.O.J. Groeneveld Meijer: Internat. eology Rev., v. 1, no. 10, p. 52-72, 11 illus., bles, Oct. 1959, 23 refs.

Twenty-two major Mn minerals are described. rystallographic and optical properties are outlined and compared. Where variations in mineral characteristics are outstanding or similarities among various minerals hinder identification, a description of diagnostic features is more fully developed. Mode of occurrence is briefly and quite generally given. Text is supplemented by X-ray powder patterns and data, as well as by photomicrographs.--G. E. Denegar.

2-198. Marchandise, H. CONTRIBUTION TO THE STUDY OF SEDIMENTARY MANGANESE DEPOSITS. Translated by W.O.J. Groeneveld Meijer: Internat. Geology Rev., v. 1, no. 10, p. 73-77, 2 diags., Oct. 1959, 4 refs.

The Fe content of rocks is 50 times that of Mn, yet sea water, as is the case for sedimentary manganese oxide deposits, contains Fe and Mn in the ratio of 2:1 respectively. Apparently, Mn enrichment occurs in marine environment. Under oxidizing conditions, Fe precipitates at a relatively low potential (Eh), Mn remaining in solution. It is noted that sedimentary Fe deposits contain comparatively little Mn. Mn precipitation is accompanied by comparatively little Fe; this is in agreement with the observed Fe content of manganese oxide deposits. Domains of Fe and Mn precipitation as carbonates (weakly oxidizing, weakly reducing environments) and sulfides (reducing environments) indicate: the carbonates are similar and can precipitate simultaneously; the sulfide of Mn is not known to occur, and, in agreement with observation, the manganese carbonate precipitates again with the sulfide of Fe.--D. D. Fisher.

2-199. McLeod, C.R. TRIAL STUDY OF HEAVY-MINERAL CONTENT OF CERTAIN DEPOSITS OF SAND AND GRAVEL IN NEW BRUNSWICK, NOVA SCOTIA, AND PRINCE EDWARD ISLAND: Canada, Geol. Survey, Paper 59-7, 21 p., table, 1959, 8 refs.

Preliminary series paper outlining the results of initial studies. Fine-grained sand was considered most suitable for sampling and concentration. In most cases samples taken for concentration consisted of 1 cu. ft. of material. A representative raw-sand sample of about 2 lb. was also taken. The cubic-foot samples were concentrated in the field by a rocker, sluice-box, or gold pan, or by combinations of these methods. The most efficient method was preliminary concentration of the material with the sluice-box followed by careful panning to produce a final field concentrate that was dried and bagged. Most concentrates were examined in the field under a binocular microscope to determine whether or not significant amounts of heavy minerals of obvious economic interest were present. In the laboratory the sample was screened, split, and separated into a strongly magnetic fraction with a hand magnet and into light and heavy fractions using bromoform. About 3 g. of the heavy fraction was taken for semiquantitative spectrographic analyses. The remainder was separated by an electromagnetic separator into 4 products of varying magnetic susceptibilities and a nonmagnetic product. The components of these fractions

were identified and the percentages estimated by grain count. The results of the investigation are tabulated at the end of the report.--H. M. A. Rice.

None of the deposits of sand and gravel studied appeared to contain sufficient quantities of heavy minerals to be workable under current marketing conditions, but small quantities of minerals that would be of economic interest in large deposits were found, and extensive sand and gravel deposits were seen. Glaciation appears to have destroyed, or glacial deposits to have covered, any concentrations that may have existed prior to glaciation. The deposits most likely to contain heavy-mineral concentrates of commercial interest are those formed from reworked glacial material, or recent deposits.--From auth. concl.

2-200. Hastings, Earl L. PHOSPHATE DEPOSITS OF LIMESTONE COUNTY, ALABAMA: Alabama Acad. Sci., Jour., v. 30, no. 4, p. 9-13, chart, Apr. 1959, 9 refs.

Weathered Ordovician limestones are the chief source rock for the phosphate deposits. The stratigraphic position of these limestones in Limestone County is given. The phosphate deposits are described and theories of origin discussed. The latter involves the origin of the source rock as well as the derivation of the phosphate deposit from it. A more detailed mapping of the phosphate deposits must be made before any mining programs can be developed. --L.M. Dane.

2-201. Malde, Harold E. GEOLOGY OF THE CHARLESTON PHOSPHATE AREA, SOUTH CAROLINA: U.S. Geol. Survey, Bull. 1079, 105 p. 5 illus., 4 maps (geol. map in pocket, scale 1:24,000), 2 charts (1 in pocket), sec., profile, 8 diags. (3 in pocket), 2 graphs, 5 tables, 1959, 142 refs.

The Charleston phosphate area, part of a district from which phosphate was produced from 1867 to 1938, lies NW. of Charleston, between the Ashley and Cooper rivers. The exposed rocks are marine and range in age from Oligocene to Pleistocene. Soils and swamp debris obscure much of the area.

The Oligocene Cooper marl, a soft, very fine-grained, impure carbonate deposit, is the oldest formation exposed, cropping out in the river bluffs. The Cooper marl dips southward from 8 to 14 ft. per mi. and overlies beds of Eocene age upturned on the N. From a thickness of 200 ft. near Charleston the Cooper marl thins and pinches out 20 mi. N. It thickens southwestward to at least 280 ft. Carbonates in the Cooper are mainly calcite, but dolomite locally replaces calcite in the upper part. Other constituents are sand, clay, phosphate, and water. The marl is massive and smooth textured. Fossils suggest deposition in relatively cool water, 100 to 200 fathoms deep. Mollusks from outcrops high in the Cooper near the coast indicate a late Oligocene age, but other fossils farther inland, closer to the base, are early Oligocene.

Miocene formations in the region are thin and discontinuous. The lower Miocene is absent, except possibly for a limestone bed, 1 ft. thick, 30 mi. NW. of Charleston. The middle Miocene Hawthorn formation, limy or marly phosphatic sand and clay, crops out along the Savannah River, but thins northeastward and apparently is missing at Charleston. The Hawthorn dips S. about 4 ft. per mi. A bed of coquina as much as 10 ft. thick and a mile broad, part of the upper Miocene Duplin marl, is buried by younger deposits in the eastern part of the area, and crops out on the Cooper River and Goose Creek. The Duplin thickens northeastward to a maximum of 41 ft. and rises inland to a height of 170 ft. It dips SE. about 2 ft. per mi. Fossils in the Duplin marl near Charleston resemble Pliocene species, but those farther inland are upper Miocene.

The Pliocene Waccamaw formation is not exposed, but ditch spoil SW. of the Charleston Military Airport contains Pliocene fossils apparently dredged from a shell bed about 8 ft. above sea level. Outcrops of the Waccamaw formation northeastward along the coast are at comparable altitude.

Pronounced changes in relative sea level during late Pliocene or early Pleistocene time are suggested by fossils from well cuttings found 83 ft. beneath Charleston and from an outcrop farther inland 65 ft. above sea level.

Pleistocene marine deposits cover nearly all the Charleston area. The Ladson formation, first named in this report, is the oldest and most widespread. It consists of a layered sequence of sand and clay, conglomeratic at the base, divisible into 4 members. From bottom to top the members are characterized respectively by phosphate, find sand, medium-grained sand, and coarse sand.

The Ladson formation dips seaward (SE.) about 2 ft. per mi. It rests on eroded Tertiary deposits and is as much as 35 ft. thick. Locally, at least 10 ft. of beds have been removed by erosion. Differential erosion along bedding places has formed flat benches, and weathering profiles on these benches are buried locally by surficial deposits.

Relative ages of the surficial deposits younger than the Ladson are inferred from their topographic relations. The oldest, a sand deposit on Tenmile Hill, forms ridges parallel to the coast from 35 to 45 ft. above sea level. Surficial deposits of intermediate age correlate with the Pamlico formation and form a sandy terrace rarely higher than 25 ft. above sea level. The youngest deposits are on terrace benches along the estuary of Goose Creek and range from 20 to 25 ft. above sea level.

The phosphate rock is phosphatized Cooper marl reworked into the lower part of the Ladson formation. Mineralogically, the phosphatic material is carbonate-fluorapatite, a common marine phosphate whose composition can be expressed by the formula $Ca_{10}(PO_4,CO_3)_6F_{2-3}$. Amounts of calcium phosphate in the phosphate rock are proportional to amounts of calcium carbonate in the Cooper marl and average 61% "bone phosphate of lime." Presumably the phosphate rock could have formed by replacement of calcium carbonate with carbonate-fluorapatite.

Soils in the area differ according to the geologic age of the deposits on which they are formed. Those with red mottling and brown hardpan are developed on the Ladson formation. Younger deposits are little weathered, but are weakly oxidized or contain organic accumulations of plants that grew in poorly drained terrain. Progressively older soils have profiles that suggest polygenetic development.--Auth.

2-202. Socolow, Arthur A. GEOLOGY OF A BARITE OCCURRENCE, FULTON COUNTY, PENNSYLVANIA: Pennsylvania Geol. Survey, Inf. Circ. 17, 5 p., 3 illus., 2 maps, 1959, 3 refs.; reprinted from: Pennsylvania Acad. Sci., Proc., v. 33, p. 204-208, 1959.

Original paper was listed as GeoScience Abstracts 1-2899.

-203. Weber, Robert H., and Frank E. Kottlow-d. GYPSUM RESOURCES OF NEW MEXICO: New lexico, Bur. Mines & Mineral Resources, Bull. 68, l p., 6 maps, 5 pls. incl. map (in pocket), Nov. 959, 73 refs.

This report, chiefly a reconnaissance survey of ne vast gypsum deposits in New Mexico, emphasizes ne large accessible deposits of possible large-scale conomic use, but many recently located small re-erves that may be of local use are noted. Most of ne bedded gypsum is of middle Permian or Upper urassic age, whereas the gypsum dune sands and ypsite are of Quaternary age. Thick, relatively ure gypsum beds occur within 50 to 75 mi. of the io Grande valley from the Rio Chama southward Truth or Consequences; thinner beds crop out long the Pecos River valley from Acme and Ros-ell S. to the New Mexico-Texas state line. The xtensive gypsum dune sands of the Tularosa basin re not only a world-famous scenic attraction but nclude a hugh reserve of pure gypsum that is out-ide the White Sands National Monument.

Bedded deposits of gypsum, other than as sparse enses and nodules, occur in the Upper Pennsylvanian anther Seep formation; in the Permian Abo-Hueco ormation, Epitaph dolomite, Yeso formation, San ndres formation, Chalk Bluff formation or White-orse group, Castile formation, and Rustler forma-on; in the Jurassic Todilto formation; in Lower retaceous strata; within Tertiary red beds; and s Quaternary lake deposits. Quaternary gypsum unes occur in quantity in the Tularosa, Estancia, ncino, and Pinos Wells basin.

The larger accessible deposits in northern New lexico include those of White Mesa near San Ysidro hich is being exploited by the American Gypsum ompany, the Rosario deposit which is mined by the aiser Gypsum Company, the Canoncito deposit, and e deposits along the San Jose valley near Mesita nd Suwanee. The most favorable deposit in central ew Mexico is the gypsum dune sands of the Pinos ells basin, and in the S.-central part of the state, e dune sands outside of White Sands National Mon-ment in the Tularosa basin total more than 3 billion ns of 99% gypsum, but are at present within White ands Missile Range. The extensive thin to thick ypsum beds of Permian age in southeastern New lexico have been quarried locally for plaster, with e Yeso Hills deposits of gypsum from the Castile ormation being explored for use in the El Paso area.

Uncalcined gypsum, used mostly as a retarder portland cement, will probably be of most value New Mexico for agricultural uses, especially to nprove alkaline soils. The products of calcined ypsum, which aggregates about three-fourths of e total crude gypsum mined in the United States, re chiefly prefabricated wallboard and lath, followed building plasters. Large amounts of these build-g materials are required for the rapidly expanding opulation centers of New Mexico and adjoining parts the Southwest.--Auth.

-204. Knechtel, Maxwell M., Howard P. Hamlin, nd John W. Hosterman. BLOATING CLAY DEPOS-TS IN SOUTHERN MARYLAND: U.S. Geol. Survey, epts., Open-File Ser. no. 497, 25 p., 2 maps, 2 raphs, 4 tables (2 in pocket), 1959, 16 refs.

Small samples of clay taken from the St. Mary's ormation (Miocene) at widely scattered localities the southeastern parts of Calvert and St. Mary's ounties, Maryland, and retained in a small electric iln for 15 min. at temperatures between 2,000°F. and 2,200°F., yield bloated products that compare favorably in weight, strength, water absorption, and color, with some of the best lightweight aggregates produced in the United States. If a sufficient amount of the sampled clay will bloat as satisfactorily when fed in large quantities to rotary kilns, the resources of such clay in southern Maryland should be adequate in quantity and quality to satisfy much of the growing demand for lightweight aggregate along the Atlantic seaboard. Occurrence of the material at sites close to tidewater suggests that its transportation by water even to distant markets might be profitable.--Auth.

2-205. Burwell, Albert L. THE CONTINUING SEARCH FOR COMMERCIALLY ACCEPTABLE SHALES AND CLAYS. RE: DUCK CREEK SHALE, MARSHALL COUNTY: Oklahoma Geology Notes, v. 19, no. 11, p. 223-226, 3 tables, Nov. 1959, 4 refs.

A majority of the shales in Oklahoma used for brick and tile "fire" to some shade of red or salmon. Because of a considerable demand for buff-colored brick, the Oklahoma Geological Survey is looking for light-burning clay and shale. A sample of the Duck Creek shale (Lower Cretaceous) from an out-crop on State Highway 99 was tested. This shale is highly calcareous and contains about 6% of argilla-ceous limestone either as plates or nodules. It is possible to separate the limestone portion from the shale by weathering or by soaking, followed by washing out the clay-size material. The clay-sized may serve as a raw material for ceramics only if blended with suitable silica or siliceous materials. The granular shale, due to the limestone particles, would not produce a marketable expanded product unless it is subjected to a beneficiation process. This shale does not yield a satisfactory hydraulic lime but should be suitable for portland cement if properly blended, although a lower magnesia content would be preferred.

Apparently, the usefulness of this shale will be limited to certain specialized items in the field of ceramics. It should be noted, however, that other portions of the Duck Creek may be free from objectionable limestone strata or nodules and there-fore be more acceptable for commercial use.--L. M. Dane and auth. concl.

2-206. Ilin, I.V., N.A. Kuryleva, L.A. Popugaeva, and Ya.B. Sigal. CHRYSOLITES OF YAKUTIA'S KIMBERLITE PIPES AS PRECIOUS STONES FOR THE JEWELRY INDUSTRY. Prepared by the U.S. Joint Publications Research Service: Internat. Geology Rev., v. 1, no. 10, p. 45-46, illus., table, Oct. 1959.

Until recently, economically significant occur-rences of chrysolite were not known to exist in the Soviet Union. Geologic investigation of the Udachnaya kimberlite pipe by the TsNILKS has established the presence of gem-quality chrysolite in Yakutia. The crystals are varying shades of light green, the depth of coloration dependent on Fe, Mn, and, probably Cr content. So far 4,300 g. of chrysolite have been recovered from 25 cu. m. of concentrate; the crys-tals ranged in diameter from 5 to 15 mm. The value of the occurrence is enhanced by the association of diamonds, pyrope, and picroilmenite.--G. E. Denegar.

2-207. Dunning, Charles H., with Edward H. Peplow, Jr. ROCKS TO RICHES; THE STORY OF AMERICAN MINING... PAST, PRESENT AND FUTURE... AS REFLECTED IN THE COLORFUL

HISTORY OF MINING IN ARIZONA, THE NATION'S GREATEST BONANZA: 406 p., illus., maps, tables, Phoenix, Arizona, Southwest Publishing Company, 1959.

Mining engineer Dunning reviews the mining history of Arizona, period by period, from Spanish times down to 1957. Metal mining gets fullest treatment; also included are statistical tables of production, a brief glossary, and an annotated list of about 250 notable Arizona mines.--M. W. Pangborn, Jr.

2-208. Sahinen, Uuno M., and Frank A. Crowley. SUMMARY OF MONTANA MINERAL RESOURCES: Montana Bur. Mines & Geology, Bull. 11, 51 p., index map, May 1959, 173 refs.

This bulletin is essentially an abstract of the principal references on specific mineral commodities in Montana. It contains a brief description of 61 mineral commodities with a discussion of uses and major occurrences. Cumulative production figures to 1957 are included wherever possible. Each commodity is complemented by a list of selected references.--F. A. Crowley.

2-209. Griswold, G.B. MINERAL DEPOSITS OF LINCOLN COUNTY: New Mexico, Bur. Mines & Mineral Resources, Bull. 67, 117 p., 31 figs., 12 pls. (4 in pocket) incl. geol. map scale 1:380,160, 1959, 29 refs.

Lincoln County [New Mexico] has yielded a variety of metals and minerals: Au, coal, Fe, Pb, Cu, Zn, fluorite, bastnaesite, gypsum, and W. In addition, deposits of Mo, Th, U, and Mn are known, although no significant production has been recorded.

The White Oaks district produced almost $3 million in Au from the time of its discovery in 1879 until shortly after the turn of the century. This district was the leading producer for the entire county. The Nogal (Au, Ag, Pb) and Gallinas (Cu, Pb, Ag) districts produced significant amounts of metals during the late 1800's and early 1900's. Lesser districts, such as the Oscuro, Jicarilla, and Schelerville, have produced Au, Cu, and other metals intermittently in the past. Mining was revived during World War II and later years to produce Fe, fluorspar, and bastnaesite in previously known districts, but mining is now practically at a standstill. The total recorded production for Lincoln County to date is estimated at approximately $5 1/2 million.

Excluding coal, gypsum, and placers, the majority of the deposits are of hydrothermal origin, being intimately associated with the widespread igneous activity evident in Lincoln County. The temperature of deposition of the deposits extends from epithermal to pyrometasomatic. The composition of the various igneous intrusives appears to have controlled the type of mineralization found in each district.

The known deposits of the area studied do not appear to favor economic exploitation under present market conditions, but several of the Fe and fluorite deposits may be exceptions. Further exploration by courageous prospectors may completely reverse this discouraging outlook.--Auth.

13. FUELS

See also: Geologic Maps 2-10, 2-13; Areal and Regional Geology 2-45; Structural Geology 2-74; Stratigraphy 2-98, 2-99, 2-101, 2-102.

2-210. Finley, Emmett A. THE DEFINITION OF KNOWN GEOLOGIC STRUCTURES OF PRODUCING OIL AND GAS FIELDS: U.S. Geol. Survey, Circ. 419, 6 p., 3 figs., 1959.

The classification of lands within known geologic structures of a producing oil and gas field prevents acquisition by noncompetitive leasing. This report presents the procedures used by the U. S. Geological Survey in defining known geologic structures for leasing law administration.--U. S. Geol. Survey.

2-211. World Petroleum Congress, 5th, New York City, 1959. PREPRINTS OF THE PAPERS OF THE GENERAL PETROLEUM GEOCHEMISTRY SYMPOSIUM: 128 p., maps, charts, diags., graphs, tables, New York, 1959, refs.

Preprints of 21 papers presented at the General Petroleum Geochemistry Symposium held at Fordham University, June 4, 1959. The purpose of the Symposium was "to stimulate research in the field of petroleum geochemistry, to outline new avenues of approaches to existing problems and to discuss and review the information presented in these preprints."--From pref.

Each of the papers is abstracted separately below in the order in which it appears in the volume.

2-212. Bader, Richard G., D. W. Hood, and J. B. Smith. INVESTIGATIONS ON THE DISSOLVED ORGANIC MATTER AND ORGANIC ADSORPTION BY PARTICULATE MATERIAL IN SEA WATER (In: World Petroleum Congress, 5th, New York City, 1959. Preprints...Geochemistry Symposium: p. 1-6, 2 graphs, table, New York, 1959) 4 refs.

The ratio of organic to inorganic constituents in sea water is about 10^{-4}. To determine the effectiveness of methods for isolating organic materials, nutrients and C^{14}-labeled bicarbonate were added to natural cultures of sea water, and growth was permitted for 3 months, after which the material was stored in the dark for 1 year. Resistant and decomposed organic compounds were then determined. Five methods for recovery of organic material were tested; electrodialysis or coprecipitation with ferric oxide were found to be most effective.

Organic material isolated from a 5-gal. sample of sea water had an initial pH of about 2.6 and, on titrating with dilute alkali, showed a buffer effect at about pH 8 thought to be caused by carboxylic acids or amine salts.

Use of Ca^{45} showed that Ca complexes form with the organic matter. Dissolved organic matter also effects carbon dioxide equilibrium relationships indicating a dynamic system involving organic matter, carbon dioxide, and Ca in calcium carbonate deposition.

Saponification of the lipids recovered from sea water (about 0.5 mg./1) led to identification of the following acids based on fatty acids having less than 20 C atoms: lauric, 6%; myristic, 14%; palmitic, 28%; stearic, 10%; myristoleic, 8%; palmitoleic, 24%; linoleic, 2%; traces of others, 8%.

Temperature, salinity, pH, nature of mineral matter, etc., all govern the adsorption of organic materials dissolved in sea water. Curves are shown

or adsorption of aspartic acid, alanine, glucose, nd sucrose by montmorillonite and kaolinite.--I. A. reger.

-213. Bonnett, B. SOLUBLE ORGANIC MATTER N SOME ARGILLACEOUS SEDIMENTS IN GREAT BRITAIN (In: World Petroleum Congress, 5th, New York City, 1959. Preprints...Geochemistry ymposium: p. 7-8, 2 tables, New York, 1959).

Fourteen 300-g. samples were each refluxed for 0 hours with 600 ml. of a 7:3 benzene-methanol nixture. This solvent gave a larger extract than 0:15:15 : benzene:methanol:acetone. The extracts vere chromatographed on activated alumina using eptane to recover the paraffin-napthene fraction colorless solid to semisolid wax), benzene for the romatic fraction (brownish-yellow semisolids), nd pyridine and methanol for the asphalt fraction shiny black solids).

The organic extract ranged from 0.003 to 0.50% f the sediment, and the total hydrocarbon fraction mounted to 25 to 3,290 p.p.m., the latter being rom the Broxburn curly oil shale. Percentages of paraffin-naphthenes, aromatics, and asphalts are abulated.--I. A. Breger.

-214. Fox, Sidney W., and G.D. Maier. A THEORY OF FORMATION OF CARBON COMPOUNDS N THE PRIMITIVE EARTH (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 9-11, 2 tables, New York, 1959)

Synthetic protein-like substances have been preared by heating amino acids at 150°-200°C. Experments suggest that the prebiological reaction mixure was released from a perivolcanic submarine egion into a primitive marine preenironment to roduce cells. Successful synthesis requires excess spartic acid; in the absence of sufficient aspartic cid a dark water-insoluble oil is formed that may esemble petroleum. Highest yield of oil is obtained ith about a 1:1 molar ratio of aspartic acid to eucine, the mixture being heated to 200°C. for about hours.--I. A. Breger.

-215. Hodgson, Gordon W. PETROLEUM PIGMENTS FROM RECENT LAKE SEDIMENTS (In: World Petroleum Congress, 5th, New York City, 959. Preprints...Geochemistry Symposium: p. 13-, diag., 3 graphs, table, New York, 1959) 6 refs.

The alteration of chlorophyll to pheophytin is easonably well understood, but the conversion of heophytin to pigments found in petroleum is not lear. A study of this conversion was carried out sing pigments from the almost stagnant Cooking ake near Edmonton, Alberta. Analyses are given f the gyttja obtained by boring and auguring, along ith water analysis, geology, faunal assemblage, nd microbiology.

Indication was obtained for the formation of a Niorphyrin complex by heating the gyttja containing he porphyrin aggregate with nickel ammonium ulfate at pH 4 at 150°C. Kinetic studies showed at even at 10°C. only a few years would be required or extensive formation of Ni-porphyrin complexes rovided that sufficient Ni were available.--I. A. reger.

-216. Hoering, Thomas C. VARIATIONS IN THE ^{15}-N^{14} RATIO IN CRUDE OILS AND SHALES (In: World Petroleum Congress, 5th, New York City, 1959. Preprints...Geochemistry Symposium: p. 21-27, fig., 2 tables, New York, 1959) 14 refs.

N isotope ratios are given for a series of shales, for gilsonite, tabbyite, wurtzilite, and a limestone, and for 45 crude oils. The low N^{15}/N^{14} ratios in natural gas indicate that the bulk of the N is not of atmospheric origin but is derived from nitrogenous substances in living material, sedimentary rocks, or crude oil. The N^{15}/N^{14} ratios in natural gas are less than those in crude oil; the isotope ratio variations in crude oils are relatively large. Indications are that there has been a relatively large depletion of N compounds in crude oils by the formation of molecular N.--I. A. Breger.

2-217. Hoering, Thomas C., and Howard E. Moore. THE NITROGEN, NEON, ARGON, KRYPTON AND XENON IN NATURAL GAS (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 29-35, 7 tables, New York, 1959) 6 refs.

The inert gas content of the samples analyzed is about 100 times less than previously reported in the literature. N contents for 5 samples range from 2.49 to 30.99%; Ar from 28 to 243 p.p.m.; Ne from 32 to 284 p.p.b.; and Kr from 5 to 41 p.p.b.

Analyses of 33 natural gases from Arkansas, Oklahoma, California, and Texas showed Ar^{40}/Ar^{36}, 284 to 3770; Ar^{38}/Ar^{36}, 0.178 to 0.218; Ne^{20}/Ne^{22}, 9.8 to 10.8; Kr^{84}/Kr^{86}, 3.10 to 3.76; Kr^{83}/Kr^{86}, 0.650 to 1.10; Kr^{82}/Kr^{86}, 0.665 to 0.971; Kr^{80}/Kr^{86}, 0.131 to 0.240; Kr^{78}/Kr^{86}, 0.021 to 0.024; Xe^{134}/Xe^{136}, 1.11 to 1.29; Xe^{132}/Xe^{136}, 2.80 to 3.28; Xe^{131}/Xe^{136}, 2.20 to 2.72; Xe^{130}/Xe^{136}, 0.445 to 0.507; Xe^{129}/Xe^{136}, 2.70 to 2.98.
For air the ratios are: Ar^{40}/Ar^{36}, 296; Ar^{38}/Ar^{36}, 0.187; Ne^{20}/Ne^{22}, 10.3; Kr^{84}/Kr^{86}, 3.28; Kr^{83}/Kr^{86}, 0.665; Kr^{82}/Kr^{86}, 0.665; Kr^{80}/Kr^{86}, 0.131; Kr^{78}/Kr^{86}, 0.024; Xe^{134}/Xe^{136}, 1.175; Xe^{132}/Xe^{136}, 3.03; Xe^{131}/Xe^{136}, 2.39; Xe^{130}/Xe^{136}, 0.460; Xe^{129}/Xe^{136}, 2.98.

The data rule out any significant contribution of any fission or alpha-particle-induced nuclear reactions to the origin of the Ne, Ar, Kr, or Xe in petroleum natural gas.--I. A. Breger.

2-218. Miller, Stanley L. SYNTHESIS OF ORGANIC COMPOUNDS IN THE ATMOSPHERE OF THE PRIMITIVE EARTH (In: World Petroleum Congress, 5th, New York City, 1959. Preprints...Geochemistry Symposium: p. 37-41, diag., table, New York, 1959) 12 refs.

Thermodynamic considerations show that methane, ammonia, and water are the stable forms of C, N, and O as long as there is an appreciable pressure of H. Decrease of the partial pressure of H in the earth's primitive atmosphere to below 10^{-5} atmospheres resulted in the present oxidizing conditions and the formation of carbon dioxide, N, nitrate, sulfate, free O, and ferric Fe.

Assuming a reducing atmosphere to have consisted of methane, ammonia, water, and H, passage of a mixture of these gases through a spark discharge resulted in the synthesis of amino acids, hydroxy acids, aliphatic acids, urea, and N-methylurea. Total yield of products was 15% of the C added to the system as methane.

It is speculated that petroleum might have formed on primitive earth through the agency of electrical discharge on low molecular weight hydrocarbons.

Compounds greater than about C_{20} would have sufficiently low vapor pressure to accumulate.--I. A. Breger.

2-219. Nagy, Bartholomew. **THE SEDIMENTARY STRATA AS A CHROMATOGRAPHIC COLUMN** (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 43-47, graph, New York, 1959) 10 refs.

A general discussion of chromatographic processes and their potential effectiveness in separating mixtures of organic constituents flowing through sediments. Using columns of quartz and quartz coated with illite, it was possible partially to separate mixtures of triphenylmethane dyes. It is suggested that chromatography might offer a quantitative method for tracing the migration of a crude oil.--I. A. Breger.

2-220. Oppenheimer, Carl H. **BACTERIAL ACTIVITY IN MARINE SEDIMENTS** (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 49-54, diag., New York, 1959) 15 refs.

Factors influencing complex bacterial activities in surface sediments of shallow marine bays are discussed. The organic matter can support an average population of over 10^8 bacteria per g. of sediment (nearly 0.1% by volume) and 10^7 per ml. of water. A simplified cycle of organic matter in the bays is presented.

Bacteria and organic matter are both attracted to sediments with large surface, and the small interstitial spaces of clay may limit the types of bacteria, thus indirectly protecting the organic matter.

No correlation was found between sediment depth or lateral extent and pH or Eh; organic matter is not uniformly distributed, and often there are alternating layers of oxidized and reduced sediment.

Bacterial production or destruction of surface active agents may lead to hydration of sediments as well as to transport of particles in foam or surface slicks.--I. A. Breger.

2-221. Stevenson, Frank J. **RELATIONSHIPS BETWEEN SOIL, SEDIMENT, AND SEDIMENTARY ROCK BIOCHEMICALS** (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 55-59, fig., New York, 1959) 19 refs.

About half of the organic matter in subsurface soil is held within the lattice structure of clay minerals.

Chromatographic elution curves are shown for a series of amino acids and other compounds isolated from soils. Among the latter are chondrosamine and glucosamine derived from microorganisms; glucosamine may also be derived from chitin, the exoskeletal material of certain lower animals.

A biogeochemical study of N has shown that up to half the N in subsurface soils occurs as ammonium ions held in the lattice structure of silicate minerals. Granites also contain fixed ammonium ions thus providing a clue to the manner of occurrence of N in the primitive earth.--I. A. Breger.

2-222. Swain, Frederick M. **EFFECT OF HUMIC ACID AND OF STABLE SALT FORMATION ON THE DISTRIBUTION OF AMINO ACIDS IN LAKE DEPOSITS** (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 61-63, New York, 1959) 4 refs.

Lake and low moor bog sediments are characterized by little or no free amino acids. The proteins of eutrophic lake sediments yield up to 4 parts per 10,000 or more of amino acids on a dry basis. It is suggested that amino acids in peats and other humified deposits are linked to or adsorbed on humic acid micelles as proteins or peptides. The degree of humification of such deposits can be defined by C/N ratios; values of less than 9/1 indicate slightly humified material, and those over 12/1 indicate a high degree of humificiation.

Neutral bogs favor preservation of neutral and acidic amino acids in ratio of 85n/15a; alkaline bogs, 75n/25a. Acidic bogs favor preservation of some basic amino acids and degradation of acidic amino acids leading to ratios of 75-95n/5-15b/0-10a. --I. A. Breger.

2-223. Williams, Milton, and Elso S. Barghoorn. **FORMATION OF MARINE CARBONATES** (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 65-70, map, chart, New York, 1959).

Considerations point to photosynthetic processes as being directly or indirectly responsible for the precipitation of marine carbonates. Requirements for such processes are intense illumination, water reasonably free of silt, relatively high water temperature, and a sufficient supply of nutrients, especially nitrate and P. In general these conditions are met only between latitudes 30°N. and 30°S. where nutrients are related to the upwelling of deep ocean waters, usually on the western boundary of ocean basins.

Studies were carried out in the Gulf of Batabano, Florida Reef, Florida Bay, Campeche Bank, Mosquito Banks, and Bahama Banks areas. In Florida Bay the pH of surface water was 8.9 in sunlight and 8.0 after dark; phytoplankton and bottom-growing turtle grass, Thalassia testudinum, are primarily responsible for photosynthetic activity.

Field evidence indicates photosynthetic activity to be responsible for carbonate precipitation in the areas studied. C^{13}/C^{12} isotope ratios of the calcium carbonates are invariably lower than those for the bicarbonate in related waters, and more detailed interpretation of the data leads to the conclusion that all the carbonates studied were formed by life processes.--I. A. Breger.

2-224. Baker, E.G. **THE ACCUMULATION OF SEDIMENT HYDROCARBONS TO FORM CRUDE OIL** (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 71-76, 2 graphs, New York, 1959) 9 refs.

Crude oil is thought to have been produced by accumulation of trace quantities of hydrocarbons known to occur in recent sediments. If accumulation was by solution of the hydrocarbons in water expelled from the sediment, then an explanation of differences in the interrelationships of the hydrocarbons of the sediments and the composition of crude oil may lie in solubilities of the hydrocarbons in water. Studies of solubilities of hydrocarbons in ordinary water and dilute solutions of a colloidal electrolyte (sodium naphthenate) indicate such a relationship to exist, and solubility in soap micelles is found to be the means of transport. Dilution of

ich a solution by meteoric water will disperse the icelles, causing the solubilized hydrocarbons to ppear as discrete, filterable oil droplets.--I. A. reger.

-225. Breger, Irving A. ORIGIN OF PETROLEUM: EACTION OF METABOLICALLY SIGNIFICANT RGANIC COMPOUNDS IN DIAGENETIC ENVIRON- ENTS (In: World Petroleum Congress, 5th, New brk City, 1959. Preprints...Geochemistry Sympo- ium: p. 77-88, 10 diags., New York, 1959) 15 refs.

Proteins and carbohydrates are rapidly degraded compounds of no direct interest in the problem of e origin of petroleum. Under certain conditions, owever, proteins can undergo putrefaction to yield nall quantities of N bases that might be incorpo- ated in sediments and eventually appear in crude l. Lignin, if carried into marine basins in the rm of humic substances, is probably the progeni- r of kerogen rather than the precursor of petroleum.
Of the pigments, porphyrins are particularly able and have been identified in sediments and rude oil. Flavonoids, on the other hand, can be ydrolyzed and this may be one reason they have not een identified in sediments or petroleum; carotenes re also labile and have not been isolated.
The fate of fatty acids in a marine environment not completely understood. Although they may not e directly decarboxylated biochemically, they can e converted into oxygenated or dehydrogenated cids that are more reactive than the parent com- ounds. Illustrations are given of Diels-Alder eactions that could account for the formation of e alicyclic and aromatic hydrocarbons of crude l.
It is most likely that crude oil is generated in ediments containing high concentrations of lipids. etroleum, then, could be formed in marine, brack- sh, or fresh-water environments, and the variety f hydrocarbons would depend upon the contributory pids. The paraffinic character of old oils and aphthenic and aromatic character of young oils ould be related to variations in saturated and un- aturated lipids. --Auth.

-226. Gillet, Alfred C. GEOCHEMICAL STUDIES ND EXPERIMENTAL RESEARCH ON THE POSSIBLE ORMATION OF NATURAL OIL FROM CELLULOSE n: World Petroleum Congress, 5th, New York City, 59. Preprints...Geochemistry Symposium: p. 89- , 2 diags., New York, 1959) 5 refs.

Many analyses for coals, cellulose, lignin, ugar, bitumens, wood, and other substances are lotted on modified Seyler diagrams (% H vs. % C). is concluded that, starting with cellulose, dismu- ation or hydroxyl exchange in an alkaline or neutral edium leads to hydrocarbons or related products epending upon the nature of the catalyst. --I. A. reger.

- 227. Gussow, William Carruthers. KNOWLEDGE N THE ORIGIN OF OIL (In: World Petroleum Con- ress, 5th, New York City, 1959. Preprints...Geo- hemistry Symposium: p. 97-100, New York, 1959).

A short discussion of occurrences of crude oil ith suggestions regarding bacterial and catalytic ctivity in its formation and migration. --I. A. Breger.

-228. Piha, Paivio. FORMATION OF PETRO- EUM IN WATER (In: World Petroleum Congress, 5th, New York City, 1959. Preprints...Geochemis- try Symposium: p. 101-106, 2 tables, New York, 1959) 4 refs.

It is proposed that carbohydrates react in acidic media to yield naphthenic acids and naphthenes, that paraffins are formed through hydrogenation and ring opening of paraffins, and that aromatics are formed from humic substances. --I. A. Breger.

2-229. Chilingar, George V. OXIDATION- REDUCTION POTENTIAL METHOD OF EXPLORA- TION FOR PETROLEUM DEPOSITS: A REVIEW (In: World Petroleum Congress, 5th, New York City, 1959. Preprints...Geochemistry Symposium: p. 107-110, profile, graph, New York, 1959) 11 refs.

The Levenson ORP method, the Serdobolsky ORP method, laboratory versus field determinations of ORP of the soils, change in ORP with soil character- istics and depth, and positive and fluctuating ORP anomalies are discussed. A considerable part of the information presented here was obtained from A. A. Kartsev and others, Geochemical Methods of Prospecting for Petroleum and Natural Gas (Geo- Science Abstracts 1-2020).
"The oxidation-reduction potential method of exploration for petroleum (ORP method) was first developed and used by Levenson in 1935. The ORP method involves determination of the electrical potential which develops between a hydrogen electrode and the surrounding rocks, soil, and water."
"The ORP values of 'ground' in petroliferous areas could be either abnormally low or high or could exhibit sharp fluctuations. On interpreting the ORP values, one should consider soil characteristics; sampling techniques and the effects of moisture, degree of aeration, and temperature; and geological and general physico-geographical characteristics of the investigated area. It seems that at the present stage of its development the ORP method can be used only in conjunction with the other methods of geochemical exploration."--From introd. and concl.

2-230. Mogilevsky, G. A. THE ROLE OF BACTE- RIA IN PROSPECTING FOR PETROLEUM. Trans- lated by William D. Romey (In: World Petroleum Congress, 5th, New York City, 1959. Preprints... Geochemistry Symposium: p. 111-115, 3 graphs, chart, New York, 1959).

This paper was originally published in Priroda, No. 9, p. 98-102, Sept. 1957.
In 1930, Sokolov proposed a geochemical method of prospecting for petroleum based on the discovery in surface deposits of the presence of small quanti- ties of gases which seep up from the oil or gas pools. It was later established that not only the hydrocarbon gases seeping to the surface, but also the bacteria using them, may serve as important indicators in prospecting.
The microbiological methods used in the U. S. S. R. and all variations of this method are based on finding indicator microorganisms living naturally in subsoil deposits, deep strata, and subsurface waters "Methane-oxidizing bacteria, propane-oxidizing bacteria, and a group of bacteria found in hydrocar- bons which form vapors in the atmosphere (heptane) are used as direct indicator microorganisms. De- sulfurizing bacteria, which are found in a medium containing heptane, hexane, or other vapor-forming hydrocarbons, are used as indirect indicators. Cellulose-destroying bacteria, which produce meth-

ane as a result of the disintegration of fatty acids, are used as control organisms to detect contemporary processes of disintegration of organic substances occurring in water and rocks..."

"The microbiological method at its present stage of development can be used especially in water surveys as part of reconnaissance work for oil and gas. It can also be used, especially in favorable regions, where springs and artesian wells draining bedrock deposits are present. It is most desirable to conduct these surveys in combination with other geochemical and geophysical work."

2-231. Sikka, Desh B. **RADIOMETRIC SURVEY OF REDWATER OILFIELD, ALBERTA, CANADA** (In: World Petroleum Congress, 5th, New York City, 1959. Preprints...Geochemistry Symposium: p. 117-124, 2 maps, table, New York, 1959) 17 refs.

A list of 43 oil fields of the U.S., Canada, and the U.S.S.R. is given showing type of trap and type of radiometric anomaly. Three hypotheses have been proposed to explain the anomalies: 1) diffusion of gaseous hydrocarbons to cause increased evaporation at surface resulting in deposition of radioactive salts in ground or surface waters; 2) diffusion of radioactive salts in solution to the surface; and 3) migration of subterranean waters rich in the salts to the surface.

Study of the Redwater oilfield has shown a correlation between count data and fault systems. It is concluded that if data obtained with an airborne gamma ray spectrometer are used with discretion, this survey technique may be a very useful tool in locating oil- and water-bearing areas, fault and fracture systems, and probably mineral deposits. Maps of the anomaly are shown.--I. A. Breger.

2-232. Witherspoon, Paul A. **GEOCHEMICAL METHODS OF PROSPECTING FOR PETROLEUM IN THE U.S.S.R.** (In: World Petroleum Congress, 5th, New York City, 1959. Preprints...Geochemistry Symposium: p. 125-128, chart, New York, 1959) 3 refs.

The primary source of information for this paper is a book by A. A. Kartsev, and others, Geochemical Methods of Prospecting and Exploration for Petroleum and Natural Gas (GeoScience Abstracts 1-2020).

In the past 30 years, Soviet scientists have developed many geochemical methods of prospecting for petroleum. This paper briefly reviews these geochemical methods with emphasis on the level to which they have been developed in the Soviet Union.

"These various prospecting methods are the results of the efforts of a large number of Soviet workers in several different research institutes. They have found that, in general, geochemical investigations involving horizons close to the surface are effective in those areas where the rocks have been considerably disturbed. In other areas, such as the Russian platform, surface prospecting for petroleum by geochemical methods has been confronted with many problems. Investigations of horizons that have been cored have been found to be advantageous, and certain combinations of methods are reported...to be particularly useful."

2-233. Jordan, Louise. **GAS IN CUSTER COUNTY**: Oklahoma Geology Notes, v. 19, no. 11, p. 226-229, map, Nov. 1959.

Custer County became the seventieth of Oklahoma's 77 counties productive of hydrocarbons with the discovery of North Custer field in early 1959. The discovery well flowed at a daily rate of 95 millio cu. ft. of gas (open-flow gauge) from 2 stratigraphic levels between 14,300 and 14,800 ft. in the Hunton group (Devonian-Silurian). Five tests with total footage of 56,000 ft. had been drilled into Pennsylvanian rocks previous to the discovery. A second discovery about 9 mi. SE. found gas in Early Pennsylvanian or Late Mississippian sandstones between depths of 13,360 and 13,580 ft.--Auth.

2-234. Jordan, Louise. **NATURAL GAS STORAGE IN OKLAHOMA**: Oklahoma Geology Notes, v. 19, no. 9, p. 182-191, 4 maps, 2 tables, Sept. 1959, 6 refs.

Six underground storage facilities for natural gas in Oklahoma have a total capacity of nearly 180,000 million cu. ft. and working-gas capacity of about 95,000 million cu. ft. Depleted or partially depleted natural gas fields have been used for storage of gas to meet peak sales requirements. Structure of 4 fields is anticlinal in nature, while reservoirs in 2 fields are related to faults. Reservoir rocks are sandstones of Middle and Early Pennsylvanian age and dolomite of early Permian age. The storage facilities underlie about 25,000 acres and individually range in size from 2,000 to over 7,000 acres. Cost of conversion to storage amounted to more than $4.5 million.--Auth.

2-235. National Oil Scouts & Landmen's Associatio **OIL AND GAS FIELD DEVELOPMENT IN UNITED STATES AND CANADA, 1958**: Its: Year Book 1959 (review of 1958), v. 29, 1136 p., illus., ports., maps, charts, secs., graphs, tables, Austin, Texas 1959.

An annual review of geological and geophysical prospecting, land and leasing activities, wildcat exploration, proven field development, oil and gas production, pipe line and refinery statistics, edited by George Hogan III and Jack L. Wiggins. Information is listed alphabetically by states and areas within states. Each area is subdivided into various classes of information, such as charts, discoveries, exploratory well record, geophysical prospecting, oil production, oil and gas fields, etc. Field discoveries, new pays, and extensions are listed alphabetically by counties and alphabetically by field under each county At the beginning of each geographical division of a state is a map showing which counties or areas are covered by that report. Established oil and gas fields are listed alphabetically by the field name in each area division in some areas, such as Texas, and alphabetically by counties, then field names, in other areas, such as Kansas.--From foreword.

2-236. Dawson, T. A., and G. L. Carpenter. **OIL DEVELOPMENT AND PRODUCTION IN INDIANA DURING 1958**: Indiana, Geol. Survey, Mineral Economics Ser. 5, 12 p., 2 illus., 2 tables, 1959.

A review of oil development in Indiana during 1958 and a statistical report of production in Indiana by fields.--Auth.

2-237. Chenoweth, Philip A. **IS THERE OIL AND GAS IN THE OUACHITA MOUNTAINS?**: Oklahoma Geology Notes, v. 19, no. 10, p. 198-208, Oct. 1959, 9 refs.

Six misconceptions are widely quoted by oil men

in condemning the Ouachita Mountain area of Oklahoma and Arkansas as a possible future oil and gas producing area: 1) "high carbon ratios," 2) "the rocks are metamorphosed," 3)"the sandstones lack porosity," 4) "there is no adequate source rock," 5) "the pre-Atoka rocks are all silicified," 6) "there has been extensive thrust faulting." That these are not cogent arguments is systematically brought out: no carbon ratio data exist for the region; the rocks for the most part do not show even incipient metamorphism; the sandstones are quite porous even in the most highly disturbed areas; "source" rock is at best a vague term which is as applicable here as elsewhere; pre-Atokan rocks are only in part silicified, and this in itself is not regarded as unfavorable; and thrust faulting has not been proved for the area, and in any case has no bearing on oil accumulation as witnessed by producing areas in Canada, California, and elsewhere. Both oil and gas are present in minor quantities in the region and may have migrated upward from deeper strata of the Arbuckle facies. An annotated list of test wells is appended.--Auth.

2-238. Jordan, Louise. OIL AND GAS IN DEWEY COUNTY, OKLAHOMA: Oklahoma Geology Notes, v. 19, no. 12, p. 253-255, fig., Dec. 1959.

Four new areas of oil and gas-condensate production have been discovered in 1959 in Dewey County, a 28-township area in western Oklahoma. First production for the county was found at West Valley Center field in early 1957, and the Putnam field was discovered in late 1958. Oil or condensate and gas have been found in Pennsylvanian rocks (Tonkawa sand (Missourian), Oswego lime (Des Moinesian), and Morrowan sandstone), in Mississippian limestone (Chester lime), and in Silurian carbonate (Chimneyhill of the Hunton group). Depth of production ranges from 7,500 to 14,600 ft.--Auth.

2-239. Jordan, Louise. OIL AND GAS IN ELLIS COUNTY: Oklahoma Geology Notes, v. 19, no. 10, p. 208-212, map, 2 tables, Oct. 1959, ref.

Natural gas in commercial quantity was discovered in 1952 in Ellis County, northwestern Oklahoma. Previous to 1958, only 13 tests, 3 of which recovered gas, has been drilled in the county. As of August 1959, the county has 13 gas-productive areas, 1 crude oil well, and 3 productive sandstone zones - Tonkawa, Cottage Grove, and Morrow of Pennsylvanian age. The deepest hole, drilled to 15,047 ft. in the central part of the county, penetrated the upper part of the Simpson group (Ordovician).--Auth.

2-240. A SYMPOSIUM ON THE SANDHILL DEEP WELL, WOOD COUNTY, WEST VIRGINIA. Assembled and collated by Herbert P. Woodward: West Virginia Geol. & Econ. Survey, Rept. Inv. no. 18, 182 p., maps, secs., charts, graphs, tables, 1959, refs.

This symposium includes the results obtained through study by various specialists of all data obtainable from cores and samples from the first well to be drilled into Precambrian basement rocks in West Virginia [Sandhill Well, Hope Natural Gas Co., Well No. 9, 634; located 14 mi. E. of Parkersburg, West Virginia]. Correlation by various methods of the various stratigraphic divisions penetrated is, as a whole, quite harmonious. The well drilled through a complete Ordovician section, then from upper Cambrian into definitely Precambrian basement rocks, with a calculated (Rb-Sr) age of 940 million years. Papers are also included on areal geology, nature of the Burning Springs anticline on which the well was drilled, and on the actual operation of drilling.--O. L. Haught.

The papers were presented at the joint meeting of the Appalachian Geological Society and the Pittsburgh Geological Society, at Blackwater Falls Lodge, Tucker County, West Virginia, Oct. 11-12, 1957. Contents of the symposium are given below. Those papers having abstracts are listed below with capitalized titles, and the abstracts follow in the order in which they appear in the symposium.

2-241. Harris, Leonard D. ORDOVICIAN ROCKS OF THE SANDHILL WELL IN WEST VIRGINIA (In: A Symposium on the Sandhill Deep Well...: West Virginia Geol. & Econ. Survey, Rept. Inv. no. 18, p. 53-68, chart, 3 secs., 4 cores, 1959) 3 refs.

The Hope Natural Gas Company Sandhill well no. 9, 634 was completed in Precambrian rocks in Feb. 1955. Ordovician rocks in this well occur in the interval between 7,811 and 11,737 ft. and are subdivided from the top downward into the Juniata formation, the Martinsburg shale, the Trenton limestone, a Middle Ordovician limestone sequence, and the Beekmantown dolomite.

The Juniata formation, which in the Sandhill well consists of 614 ft. of grayish-red and greenish-gray shale and some interbedded siltstone, overlies a thickness of 1,103 ft. of greenish-gray and medium-gray to dark-gray shale assigned to the Martinsburg shale. The Trenton limestone, a medium-gray coquinoid limestone with a bentonite zone in its lower part, is 202 ft. thick and overlies a Middle Ordovician limestone sequence 976 ft. thick, which includes bentonite in its upper part. An unconformity at the base of the Middle Ordovician sequence is

interpreted as the same major unconformity as that at the base of similar Middle Ordovician rocks in much of central, eastern, and southern United States.

Nearly all the Lower Ordovician rocks, to which the general term Beekmantown dolomite has been applied, are dolomite containing some argillaceous and arenaceous material. Chert is abundant in the middle part, and the basal 104 ft. is dolomitic sandstone. Evidence in the cores suggests that at least the upper 927 ft. of this 1,031-ft. sequence was subjected to a long period of solution.

Rocks in the Sandhill well are correlated with rocks in southern West Virginia and SW. Virginia on the basis of gross lithologic similarity, the bentonite zone in the Middle Ordovician, and the unconformity at the base of the Middle Ordovician limestone sequence. The Juniata, Martinsburg, and Trenton formations can be correlated on a lithologic basis with some assurance, but all Middle Ordovician rocks below the Trenton can be compared only on gross lithology, and no formations are differentiated. Rocks termed Beekmantown dolomite in the Sandhill well are tentatively correlated with strata of the Mascot, Kingsport, Longview, and Chepultepec formations in SW. Virginia.--Auth.

2-242. Marsden, S.S., F.A. Horgas, and R.K. Gourley. **PHYSICAL PROPERTIES OF A SERIES OF DOLOMITE CORES** (In: A Symposium on the Sandhill Deep Well...: West Virginia Geol. & Econ. Survey, Rept. Inv. no. 18, p. 99-110, 3 tables, 1959) 3 refs.

Porosities, permeabilities, and mineral densities have been measured for a series of dolomite cores from West Virginia. Most of the porosity is due to vugs rather than intergranular pores and most of these vugs are interconnected. Porosities measured on small plugs have been shown by a statistical test to be unreliable for this sort of formation. Most of the samples studied have a mineral density which is essentially that of dolomite. Several have lower densities which may be due to inaccessible void space or to the presence of a less dense mineral.

All of the cores have permeability to gas, although there is an appreciable variation from one to the next. Most of this permeability is due to vugs and fractures. Horizontal permeability is appreciably greater than vertical. --Auth.

2-243. Robertson, Eugene C. **PHYSICAL PROPERTIES OF LIMESTONE AND DOLOMITE CORES FROM THE SANDHILL WELL, WOOD COUNTY, WEST VIRGINIA** (In: A Symposium on the Sandhill Deep Well...: West Virginia Geol. & Econ. Survey, Rept. Inv. no. 18, p. 111-144, 5 graphs, 4 tables, 1959) 11 refs.

The density, porosity, thermal conductivity, magnetic susceptibility, elastic moduli, and dielectric constant were measured on 132 cores from the Sandhill well. Of these cores, 41 are from 925 ft. of Black River and Trenton limestone, and 52 are from an underlying 1,110 ft. of Beekmantown dolomite. These are contiguous sequences of Middle and Early Ordovician age.

Chemical analyses were made of most of the limestone and dolomite cores; the mean sum of $CaCO_3$ + $MgCO_3$ is 91% for the limestone sequences and is 83% for the dolomite sequence. In addition, qualitative mineralogical compositions were determined on all cores with an X-ray diffractometer. The chemical and mineralogical compositions of the limestone and of the dolomite sequences are very uniform to the limits of analytical accuracy, about 5%.

The mean densities of the limestone and dolomite sequences are 2.696 gm./cc. and 2.814 gm./cc., respectively. The variation within each sequence is very low, less than the observational accuracy of 0.4%. The mean porosity is about 0.4% for both the limestone and dolomite sequences, with a standard deviation of about 0.3% for both. The mean thermal conductivities for the limestone and dolomite sequences are 6.77 mcal./cm. sec. deg. C. and 11.39 mcal./cm. sec. deg. C. respectively; the local and long range variations for both sequences are about 5%. The mean magnetic susceptibility is 3.0×10^{-6} cgsu/cc. for the limestone sequence and 2.2×10^{-6} cgsu/cc. for the dolomite sequence; these indicate that any magnetite content must be < 10 p.p.m. The mean dielectric constant ratio relative to air is 9.4 for the limestone and 8.6 for the dolomite; the measurements were made on dry samples at 1,000 cycles/sec.

Good measurements of the elastic moduli were made on only 4 limestone and on 5 dolomite samples; mean values for limestone and dolomite respectively are as follows: Young's modulus, 7.75×10^5 bars and 8.02×10^5 bars; rigidity modulus, 2.98×10^5 bars and 3.28×10^5 bars; Poisson's ratio, 0.30 and 0.22; longitudinal internal friction 0.021 and 0.033; and shear internal friction 0.007 and 0.014. All other determinations of the moduli were much less reliable than these because of imperfections of bonding of grains in the rocks.

The chemical and mineralogical compositions and all the physical properties show that the limestone and dolomite sequences are each remarkably uniform. This uniformity and the abrupt change from one rock to the other shows an extraordinarily close geologic control. Although disguised by the errors of measurement, the data indicate that the local variation and the long range variation in composition and properties in each sequence are about equal. If the thermal conductivities of the rocks are measured, temperature logs from wells can be used to identify geologic formations in a region of uniform heat flow; thus practical use of the temperature logs can be made in prospecting.--Auth.

2-244. Bass, Manuel N. **BASEMENT ROCKS FROM THE SANDHILL WELL, WOOD COUNTY, WEST VIRGINIA** (In: A Symposium on the Sandhill Deep Well...: West Virginia Geol. & Econ. Survey, Rept. Inv. no. 18, p. 145-158, map, 1959) 8 refs.

Precambrian crystalline rocks were encountered in the Sandhill well at a depth of 13,276 ft. The interval from 13,276 to 13,288 ft. may be transported "granite wash," or, more likely, weathered crystalline rock in situ. Below 13,288 ft. the rocks are probably relatively fresh and in place. The crystallines were cored from 13,314 to 13,331 ft. (total depth).

The uppermost part of the core is an amphibolite of monzodioritic composition at least 5 ft. thick and is believed to represent a sill or flow. An essentially identical 9-in. layer occurs between 13,327'9" and 13,328'6". The major part of the core (11 ft.) is a gray to red, banded and laminated gneiss of granodioritic to tonalitic (perhaps trondhjemitic) composition, with a few bands of syenite, monzonite, and granite. The gneiss is believed to represent metamorphosed sedimentary or possibly tuffaceous

rocks. The structural trend is probably N-S.

The rocks were metamorphosed under conditions of the amphibolite facies. This involved intense shearing, and probably plastic flow along at least one zone in which prominent quartz veins are also found. Retrograde metamorphism led to chloritization and slight carbonatization of amphibole and feldspar. There is evidence for metasomatic effects, especially introduction of potash, so that present compositions are not necessarily those of the original rocks.

Correlation with the basal injection complex of the Blue Ridge province is considered unlikely. More likely is correlation with Greenville-type rocks to the NNE. or with subsurface metamorphic rocks of western Ohio and southeastern Michigan. The latter are believed to be an extension of the Greenville subprovince, but could possibly be a S.-southeastward extension of the Huronian S. of Lake Superior. The age of the rocks probably exceeds 750 million years.--Auth.

2-245. Harbour, R. L., and George H. Dixon. COAL RESOURCES OF TRINIDAD-AGUILAR AREA, LAS ANIMAS AND HUERFANO COUNTIES, COLORADO: U.S. Geol. Survey, Bull. 1072-G, p. 445-489, 2 maps (geol. map under separate cover, scale 1:31,680), 4 secs. (under separate cover), 1959, 61 refs.

The Trinidad-Aguilar part of the Trinidad coal field lies in southeastern Colorado in the Raton mesa coal region between the Great Plains on the E. and the Sangre de Cristo Mountains on the W. The mesas are high tablelands eroded in coal-bearing Cretaceous and Tertiary rocks that are downfolded into the Raton basin.

The surface rocks of the area are relatively undeformed and dip gently westward into the interior of the Raton basin. They represent an essentially continuous cycle of late Cretaceous and early Tertiary deposition. The plains to the E. are marine shale and thin limestone comprising the Carlile, Niobrara, and Pierre formations. The resistant rocks of the coal field top the soft shale of the plains. In ascending order, these rocks consist of: the Trinidad sandstone, a nearshore marine deposit; the Vermejo formation, a coastal swamp deposit; the Raton formation, a flood-plain and swamp deposit; and the Poison Canyon formation, a conglomeratic deposit of terrestrial origin. Pennsylvanian, Permian, Jurassic, and older Cretaceous rocks crop out in the mountains to the W. and probably underlie the mapped area. Eocene rocks that overlie the Poison Canyon in the interior of the basin have been removed from the area by erosion.

Folding, dike and sill injection, and uplift followed Eocene deposition, and the area was peneplaned by Miocene or Pliocene time. A broad uplift followed, and the resulting erosion developed the present topography.

The area contains vast fuel resources of bituminous coking coal in the Vermejo and Raton formations. More than 80 million tons of coal has been produced from the area. Nearly 3 billion tons is estimated to remain in beds of mineable thickness. About one-tenth of the coal at the outcrop has been transformed into natural coke by igneous intrusives.

No oil or gas has been produced in the area, and the surface rocks show no structures that might favor accumulation of oil and gas. However, stratigraphic traps may occur in an eastward-thinning wedge of Pennsylvanian rocks beneath the area. --Auth.

2-246. Deasy, George F., and Phyllis R. Griess. MAPS OF CURRENTLY PRODUCING BITUMINOUS COAL SEAMS IN PENNSYLVANIA: Mineral Industries, v. 28, no. 6, p. 4-6, 17 maps, March 1959.

More than 60 bituminous coal seams are incorporated within the Pennsylvanian and Permian strata of western Pennsylvania. Only 18 of these are being mined today, 8 on a large to moderate scale (over 1 million tons annually), 10 on a small scale. The distribution of coal production from each of the 18 producing seams is mapped in order to illustrate regional differences in the relative importance of the various seams. Major production from the Pittsburgh seam, the highest quality and most easily mined bituminous coal bed in Pennsylvania, is derived from deep mines operated in Washington and Greene counties; also in Fayette, Westmoreland and Allegheny counties. Production from the upper Freeport seam, second in production, is widely dispersed in 14 counties. Most of the output comes from deep mines, although stripping also is fairly important. Production from the lower Kittanning seam is exceptionally widespread, occurring in 23 counties, due to its lower stratigraphic position. Most production is derived from deep mines with lesser amounts being accounted for by stripping operations.

Unlike previously discussed major seams, the lower Freeport and upper and middle Kittanning seams are generally less suitable for mining. Production from the Brookville and Clarion seams is obtained almost exclusively from stripping. Of the remaining 10 seams, only the Sewickley has any significance. Most of its output comes from underground mines in Greene County.--G. E. Denegar.

14. ENGINEERING GEOLOGY

See also: Geologic Maps 2-11; Areal and Regional Geology 2-49.

2-247. Butkovich, Theodore R. SOME PHYSICAL PROPERTIES OF ICE FROM THE TUTO TUNNEL AND RAMP, THULE, GREENLAND: U.S. Snow, Ice & Permafrost Research Establishment, Research Rept. 47, 17 p., 22 illus., 11 diags., 8 graphs, 11 tables, 1959, 7 refs.

Various mechanical properties such as strength, elastic modulus, and density of TUTO tunnel and ramp ice were determined. Results of unconfined compressive strength, ring tensile strength, and flexural strength tests are given. Photographs of included bubbles and grain size and shape are shown for each of 6 types of ice tested. Petrofabric diagrams for each type of ice are included. No significant differences in strength were found between horizontal and vertical cores in the ice tunnel, although differences between types of ice are noted. Crushing strength values found for tunnel ice generally fit the empirical equation relating crushing strength to density which was found for high-density snows. However the values for ramp ice do not fit the equation when the average density values are used, probably due to the layering. The empirical equation relating

ring tensile strength to density of high-density snows gives results approximately 20% greater than those obtained for tunnel ice. It appears that grain size influences the results. Ice with large grains consistently gives lower values.

Flexural strength of the ramp ice is about half that of the tunnel ice. Comparing these results with the ring tensile values leads to the conclusion that the beams tend to fail in the lowest-density (mostly bubbly) bands.

Temperature curves as a function of depth into the wall and along the tunnel length are presented. A 30-day study of deformation in a 100 x 30 ft. room at 650 ft. into the tunnel indicated that the room is closing primarily by a block action with rates of closure being less only very near the walls. --Auth. summ.

2-248. Seed, H.B., and C.K. Chan. **STRUCTURE AND STRENGTH CHARACTERISTICS OF COMPACTED CLAYS: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 85, no. SM5, pt. 1, p. 87-128, 90 graphs, Oct. 1959, 9 refs.**

The influence of soil structure on shrinkage, swelling, swell-pressures, stress-deformation characteristics, undrained strength, pore-water pressures, and effective strength characteristics is described, and examples of the relationships between composition and the "as-compacted" strength of compacted clays are presented. The influence of shear strain on soil structure is demonstrated and used to explain the effect of various methods of compaction on soil strength characteristics.

It is shown that although soil structure may have a profound effect on undrained "strengths" determined at low strains because of its influence on pore-water pressures, it appears to have little or no effect on soil strength characteristics expressed in terms of effective stresses. It is also shown that the structure developed in a compacted soil is greatly influenced by the shear strains induced in the soil during the compaction process; such strains apparently tend to produce a dispersed arrangement of soil particles and thus, for soils in which the interparticle forces are not so great that flocculation will occur under all compaction conditions, methods of compaction inducing shear strains produce a greater degree of particle orientation, lower strengths at low strains in undrained tests, greater shrinkage and less swelling than methods of compaction inducing little shear strain.--From auth. synopsis and concl.

2-249. Swiger, W.F., and H.M. Estes. **MAJOR POWER STATION FOUNDATION IN BROKEN LIMESTONE: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 85, no. SM5, pt. 1, p. 77-86, illus., 4 maps, sec., Oct. 1959.**

Subsurface pinnacles of limestone surrounded by rubble in clay of varying consistency require detailed examination at each building column and equipment foundation to establish an economical type of design for each foundation for a steam power plant.

In spite of the discouraging conditions found under the site [30 mi. SW. of Chicago], a safe and economical foundation was developed by use of caissons to sound rock where required and of concrete footings and mats in localized areas where sufficient rock was found in place to support the loads imposed.--From auth. abs. and concl.

2-250. Cass, James R., Jr. **SUBSURFACE EXPLORATIONS IN PERMAFROST AREAS: Am. Soc. Civil Engineers, Soil Mech. & Found. Div., Jour., v. 85, no. SM5, pt. 1, p. 31-41, 5 illus., table, Oct. 1959.**

Subsurface investigation programs were undertaken at Frobisher Bay Air Base, Baffin Island, Northwest Territories, Canada, in mid-summer 1955 and late summer 1957.

From the comparison of the drilling procedures described in this paper, it seems that core drilling is the better method for subsurface investigation in the Arctic if the full coring capability of the drill can be utilized. Experience to date indicates that the use of compressed air is the key to developing this capability. Factors which may affect core recovery are rate of air flow, cooling of air, size of core, speed of rotation, rate of feed, and type of bit. Also there may be a depth limitation beyond which it is not possible to drill without excessive air requirements.

Once a satisfactory drilling method has been developed, it is believed that progress can be improved further by making the investigations in the early spring of the year. At this time, the ground is frozen to the surface, and there would be no need of drive sampling in the active layer or of casing the hole to seal out the ground water. The disadvantage is the effect of the weather on personnel, and, consequently, on production. The 1957 boring program indicates that further field experience, using compressed air with a core drill, will result in procedures that will ensure consistent recovery of permafrost cores.--From auth. summ.

15. MISCELLANEOUS

2-251. Namowitz, Samuel N., and Donald B. Stone. EARTH SCIENCE - THE WORLD WE LIVE IN: 2d ed., 614 p., illus., maps, secs., diags., graphs, tables, Princeton, New Jersey, D. Van Nostrand, 1960, refs.

Written basically as a secondary school textbook, this revised edition incorporates results of the most recent research in the fields covered by the text. Much of this new material represents findings of the International Geophysical Year. The book has been brought up to date in such fields as "the climate and topography of Antarctica, the countercurrents and deep water circulation of the ocean, magnetic storms, sunspots, auroras, mineral wealth in the ocean, jet streams and radiation bands in the atmosphere, the topography of the ocean floor, and the composition of the earth's interior."

The chapter on rocks and rock-making minerals has been expanded and a chapter, Minerals of Economic Importance, has been added. A new unit, The Earth and Its History, consists of 4 chapters. Latest figures for the Geologic Timetable are given. The chapter, The Sun and Its Family, has been expanded to include a discussion of artificial satellites and problems of space travel. A glossary of 600 terms has been added, and the index has been considerably expanded. A second color has been introduced throughout the text to stress important elements in line drawings and to serve as a general

teaching aid.

The book is divided into 6 major units. Unit 1, The Earth and Its Land Forms, the longest unit, is concerned with geomorphology, the study of rocks and minerals, and the reading of topographic maps. Unit 2, The Earth and Its History, briefly discusses the geological development of the earth from its beginning and the development of living things. Astronomy is covered in Unit 3, The Earth and the Universe. Unit 4, The Earth and Its Atmosphere, discusses meteorology. Oceanography is studied in Unit 5, The Earth and Its Oceans, and Unit 6, The Earth and Its Climates, is concerned with climatology.

The following sections are generally found after each chapter: Have You Learned These? Topic Questions, General Questions, Student Activities, Supplementary Topics, and Suggestions for Further Reading.--L. M. Dane.

2-252. Smith, Guy-Harold, ed. CONSERVATION OF NATURAL RESOURCES: 2d ed., 474 p., illus., maps, diags., graphs, tables, New York, John Wiley & Sons; London, Chapman & Hall, 1958, refs.

Revised edition of a book first published in 1950, surveying present aims, methods, needs, and accomplishments of conservation in the United States. Nineteen specialists have contributed to the second edition, 5 sections have been completely rewritten, and a new chapter on economics and conservation has been added, in addition to new material in other chapters. The book is divided into 8 parts. Contents are as follows:

PART 1.
1. The Development of Conservation in America, by Alfred J. Wright.
2. The Public Domain and its Disposal, by Stephen S. Visher.
3. Economics and Conservation, by Harold H. McCarty.

PART 2.
4. The Great Soil Groups and their Utilization, by Louis A. Wolfanger.
5. Soil Conservation, by William A. Rockie.
6. Irrigation in the United States, by H. Bowman Hawkes.
7. Reclamation of Wet and Overflow Lands, by Lowry B. Karnes.
8. Grassland Resources, by Herbert C. Hanson and Warren C. Whitman.
9. The Land We Possess, by Guy-Harold Smith.

PART 3.
10. Our Forest Resources, by Oliver D. Diller.
11. The Practice of Forest Conservation, by Oliver D. Diller.

PART 4.
12. Water Supply for Domestic and Industrial Uses, by John H. Garland.
13. Water Power and Its Conservation, by Guy-Harold Smith.
14. Our Waterways and Their Utilization, by Edwin J. Foscue.
15. Floods and Flood Control, by Guy-Harold Smith.

PART 5.
16. Conservation of Mineral Resources, by Guy-Harold Smith.
17. The Mineral Fuels, by E. Willard Miller.

PART 6.
18. Conservation of Wildlife, by Charles A. Dambach.
19. Fisheries for the Future, by Howard H. Martin.

PART 7.
20. Recreational Resources, by Edward C. Prophet.
21. The Conservation of Man, by Lawrence A. Hoffman.

PART 8.
State and Local Planning, by Harold V. Miller.
National Planning and the Conservation of Resources, by Guy-Harold Smith.

2-253. Eckel, Edwin B. PARTIAL BIBLIOGRAPHY OF UNCLASSIFIED LITERATURE ON GEOLOGY IN THE NUCLEAR AGE (EXCLUSIVE OF RADIOACTIVE RAW MATERIALS): 9 p., [Denver, Colorado, U.S. Geological Survey, 1959?]

Ninety-three references, some very briefly annotated, are presented under the following headings: general background; underground nuclear tests; open file reports, U. S. Geological Survey; peaceful uses of nuclear explosions; disposal of radioactive wastes. --A. C. Sangree.

2-254. Branson, Carl C. PUBLISHED WORK OF CHARLES NEWTON GOULD (1868-1949): Oklahoma Geology Notes, v. 19, no. 12, p. 239-252, Dec. 1959, refs.

Gould's philosophy was to publish voluminously and on all manner of subjects. In his career he published 271 papers, and these references are given. Many are in obscure journals and 12 references could not be found in libraries. --Auth.

2-255. British Columbia, Minister of Mines. ANNUAL REPORT FOR THE YEAR ENDED 31ST DECEMBER, 1958: 66, 185 p., illus., maps, graphs, tables, Victoria, 1959.

Production in 1958 brought the accumulated value of the mineral output of the province past $4 billion. In 1958 the combined value of mineral products was $146, 875, 081. Thirty-eight items are listed, 15 under metals, 7 under industrial minerals, 13 under structural materials, and 3 under fuels. Pb contributed 23. 6% and Zn 29. 4% of the value of the mineral output, asbestos contributed 5. 2%, Au, Ag, and Cu ranged from 4. 6 to 2%. The value of mineral output for 1958 was materially less than that of recent years because of reduced prices for Cu, Pb, and Zn, and reduced output of Au, Ag, Cu, coal, and several other products. Increases were recorded for Fe ore, petroleum and natural gas.

The number of lode-mineral claims recorded in 1958 was 13, 459, compared with 12, 110 in 1957. Lode-mine exploration increasingly is carried on by large companies doing geological, geophysical, and geochemical work, stripping with heavy equipment, diamond drilling, and solving transportation problems by using fixed-wing aircraft or helicopters.

Exploration for oil and gas was carried on actively mainly in NE. British Columbia. More than 40 drilling rigs operated during 1958, and 484, 287 ft. of drilling was done on 112 wells.

This report contains introductory sections dealing with statistics and departmental work, followed by sections on lode metals; placers; structural materials

and industrial minerals; petroleum and natural gas; inspection of lode mines, placer mines, and quarries; coal; inspection of electrical equipment and installations at mines and quarries.--A. C. Sangree.

2-256. Alabama, Geological Survey, and Alabama, State Oil and Gas Board. **ANNUAL REPORTS FOR THE FISCAL YEAR OCTOBER 1, 1957-SEPTEMBER 30, 1958: 41 p., maps, graphs, tables, 1959.**

2-257. Lyon, Duane. **BASIC METRICAL PHOTOGRAMMETRY: [475] p., illus., diags., graphs, tables, St. Louis, Missouri, John S. Swift, 1959, refs.**

This text is Vol. 1 in a proposed series of 3 textbooks on photogrammetry. Vol. 2 will cover practical applications of metrical photogrammetry, and Vol. 3 will describe techniques to be used in procuring metrical photographs. Small portions of this book were originally published under the title College Photogrammetry.

This text is concerned solely with the basic principles of metrical photogrammetry including pertinent equipment and techniques of general interest. It is not concerned with photo interpretation or photogrammetric compilation procedures. The reader is assumed to have a good working knowledge of high school algebra, trigonometry, and descriptive geometry.--From auth. foreword and pref.

Contents are as follows:

Introduction of Metrical Photogrammetry, [23 p.].
Principles of Stereoscopy, [40 p.], 14 refs.
Basic Photogrammetric Theory, [46 p.], 9 refs.
The Effect of Errors in Photogrammetry, [32 p.], 17 refs.
Analytical Geometry, [30 p.], 17 refs.
Photogrammetric Instruments, [146 p.], 26 refs.
Operational Techniques, [95 p.], 34 refs.
History of Photogrammetry, [10 p.].
Photogrammetric Nomenclature, [53 p.], 3 refs.

2-258. Theurer, Charles. **COLOR AND INFRARED EXPERIMENTAL PHOTOGRAPHY FOR COASTAL MAPPING: Photogramm. Eng., v. 25, no. 4, p. 565-569, illus., port., Sept. 1959, 5 refs.**

Color, infrared, and panchromatic aerial photography of shoal areas have been obtained for comparative studies for applications to coastal mapping. The general idea was originally to continue to use conventional panchromatic photographs for mapping, and also to use the other types in an auxiliary interpretative manner in order to assist the identification of the water line and significant navigational features. One possible application of color photography is for determining relative depths, not replacing the hydrographic survey, but isolating shallow areas which may require a dense hydrographic study, and assisting in the planning of wire-drag operations. Special devices and techinques are discussed, including the problem of obtaining aerial photographs at a specific stage of the tide, and the possible adaptation of stereoscopic instruments.--Auth.

2-259. Dodge, Hugh F. **ANALYTICAL AEROTRIANGULATION BY THE DIRECT GEODETIC RESTRAINT METHODS: Photogramm. Eng., v. 25, no. 4, p. 590-595, port., 7 diags., Sept. 1959.**

The paper courses the history of the U. S. Geological Survey's research project on analytical aerotriangulation. The objectives of the program are discussed along with the general plan for attacking the problem. The main body of the text is devoted to describing the basic portion of the geometry of the Direct Geodetic Restraint Method of analytical aerotriangulation. This description is confined to terms familiar to the photogrammetrist and is given without recourse to mathematical formulas. A brief resume of tests already conducted or in progress concludes the paper.--Auth.

2-260. American Geological Institute. **DIRECTORY OF GEOSCIENCE DEPARTMENTS IN THE COLLEGES AND UNIVERSITIES OF THE UNITED STATES AND CANADA: Its: Rept. 11, 1960 ed., 117 p., tables, [1959].**

Two hundred fifty institutions offering a major in the geological sciences are listed. Sec. 1 lists colleges and universities offering undergraduate and graduate degrees in the geosciences, first by geographic location and then alphabetically. Sec. 2 lists faculty members in the geoscience departments of the institutions in Sec. 1, with their degrees. The name of the institution granting the highest degree to each person is also given. Sec. 3 lists 4-year institutions which have course offerings in geological sciences, but do not offer a degree in geology or geophysics. Sec. 4 lists junior colleges offering some courses in the geosciences. The colleges and universities offering summer field courses in geology are given in tabular form in Sec. 5.--M. Russell.

2-261. Pennsylvania State University, Mineral Industries Experiment Station. **PROGRESS IN RESEARCH: Its: Circ. 54, 88 p., illus., maps, graphs, 1959.**

A biennial report (1957-1959) prepared to present a unified picture of the research program and inform the leaders in Pennsylvania's government, industry, and education of the research capabilities of the staff and the extent of the instrumentation available.

The research activities described fall into the following groups and subgroups: 1) Earth Sciences: geography, geology, geophysics and geochemistry, meteorology, mineralogy and petrology. 2) Mineral Engineering: mineral economics, mineral preparation, mining, petroleum and natural gas. 3) Mineral Technology: ceramic technology, metallurgy, fuel technology. 4) Mineral Industries Experiment Station: Mineral Constitution Laboratories, Mineral Conservation Section, and the Coal Research Section.

During the 1957-1959 biennium the College completed a study of fossil fuel resources, an investigation of recurring aspects of the climate of Pennsylvania by statistical analyses, and mounted a research program on the utilization of bituminous and anthracite coals.

"Present research in the Dept. of Geology is concerned with numerous aspects of the occurrence, characteristics, and conditions of origin of rocks and rock features in the Appalachian and Rocky Mountain regions. Attention is being devoted to facies interrelationships, and paleogeography and tectonics of accumulation of sedimentary rocks; to animal and plant fossils useful in tracing sediments and interpreting environments of deposition; to coal components and origin; to rock structures that have been formed by sedimentation and by deformation; to relation of metallic ores to associated rocks

and to ore-forming processes; and to origin and distribution of the surface mantle of rock and soil." --M. Russell.

2-262. Himmelfarb, Gertrude. **DARWIN AND THE DARWINIAN REVOLUTION: 480 p., Garden City, New York, Doubleday, 1959, approx. 250 refs.**

The book is intended as a biographical, historical, and philosophical study which covers Charles Darwin, the Darwin-Wallace theory of natural selection, and the impact of that theory on society. The extent of Darwin's experience and observations as a geologist and paleontologist, and their relevance to the development of the theory are described.

A consideration of Darwin's early life and thought is followed by a tracing of the development of his ideas from the voyage of the Beagle to the publication of the Darwin-Wallace theory of natural selection. In the course of this examination, the conventional picture of his intellectual history is shown to be false in many respects. His relations with his predecessors and contemporaries are revealed to be far more complex than has been commonly supposed. The scientific status of Darwin's theories, the evidence upon which they were based, and the logic of their structure are discussed. The last sections deal with the varied and contradictory doctrines that have come under the name "Darwinism."--M. Russell.

2-263. Pearce, D. W., and J. F. Honstead. **RADIOACTIVE WASTE DISPOSAL AT HANFORD (In: Proceedings of the Thirteenth Industrial Waste Conference, May 5, 6, and 7, 1958: Purdue Univ., Eng. Ext. Dept., Eng. Bull., v. 43, no. 3, Ext. Ser. no. 96, p. 567-580, illus., 3 maps, 3 cross secs., 2 graphs, table, Sept. 1959)**

This paper deals with some of the experience and knowledge gained at Hanford Laboratories Operation, General Electric Company, Richland, Washington, concerning the controlled storage or dilution of typical nuclear plant effluents containing radioactive materials.

Nuclear plants performing chemical processing operations on irradiated fuels will always be faced with a mjaor problem of waste disposal. In general, the disposal problem is no different, except in degree, from that encountered in any chemical plant processing toxic materials. The very small amounts of radioactive material acceptable in the public water supplies makes suspect all of the effluent streams from the nuclear plant. Even condenser cooling water and process steam condensate may require special disposal practices to avoid unnecessary release of contamination to the public. In some cases it is practicable to use the natural decontamination ability of soils near the plant to dispose safely of large volume streams. In all such cases a program of detailed study of the local environment is a necessary investment.--From auth. concl.

2-264. Rich, Linvil G. **THE DISPOSAL OF HIGH-LEVEL RADIOACTIVE WASTES IN SALT FORMATIONS (In: Proceedings of the Thirteenth Industrial Waste Conference, May 5, 6, and 7, 1958: Purdue Univ., Eng. Ext. Dept., Eng. Bull., v. 43, no. 3, Ext. Ser. no. 96, p. 581-595, 5 graphs, Sept. 1959) 41 refs.**

On the basis of the present study it would appear that if an economical method is developed whereby the activity of the waste system can be concentrated and fixed in a nonleachable solid, a system of isolation is available for the ultimate, safe, and, possibly, economical disposal of high-level radioactive wastes. Essentially, the system would consist of packaging the wastes in small metal containers and then storing the containers in worked-out salt mines. --Auth. concl.

AUTHOR INDEX